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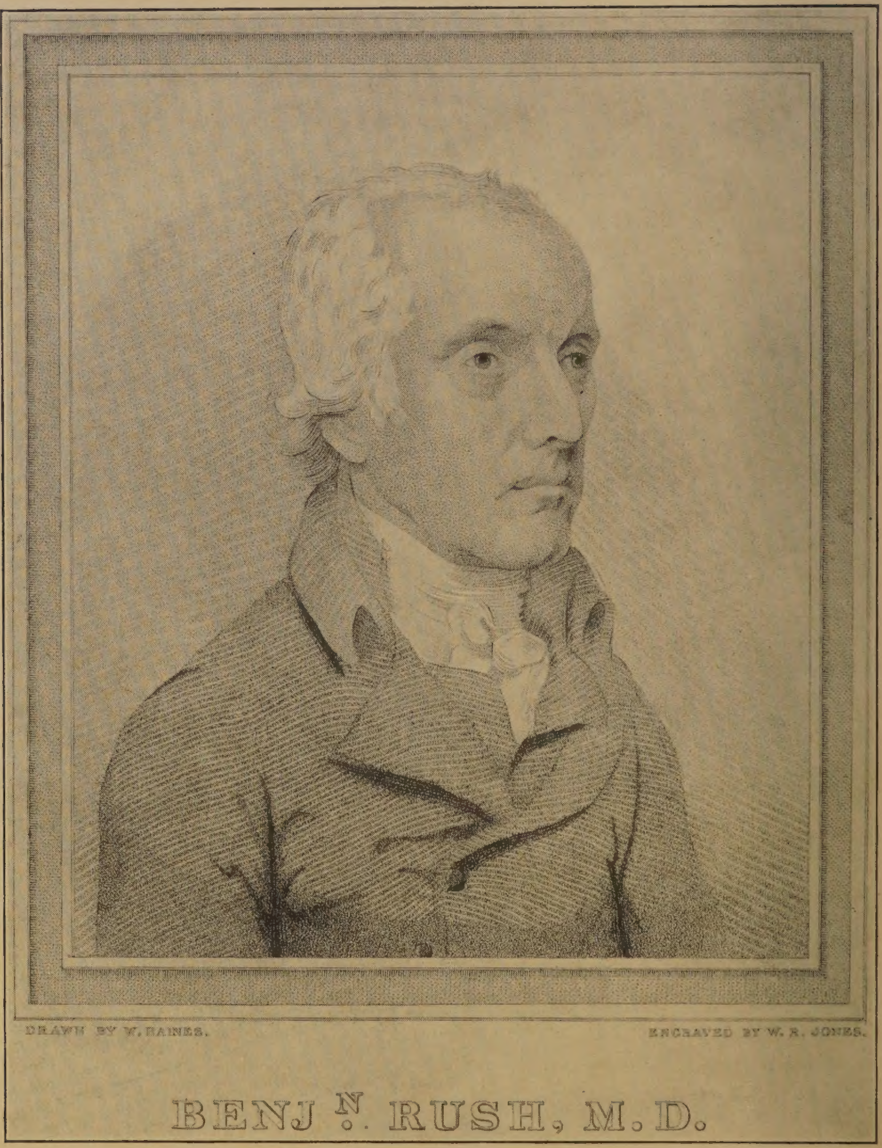
OLD CHEMISTRIES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BENJ^N. RUSH, M.D.

Benjamin Rush

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OLD CHEMISTRIES

BY
EDGAR F. SMITH
University of Pennsylvania

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PREFACE

WHAT excuse shall be offered for writing this book? Its object is to lay before interested readers a hint of the vast stores of early literature relating to chemistry, of which many are ignorant. It may be that the few volumes alluded to in the following pages will elicit further search along similar lines.

The author's hope is that sometime—how soon he knows not—but, sometime—the history of chemistry will be given its place in the curriculum of studies in every institution of learning where the science itself is studied; for it is, indeed, a very comprehensive subject.

E. F. S.

PHILADELPHIA, PA.,
January, 1927

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OLD CHEMISTRIES

CHAPTER I

THERE are those who think and, it may be, declare that chemists ought not to dream, yet I frankly confess as I have sat gazing at a near-by, old-fashioned book case, that I have dreamed—because, the higher shelves carry musty volumes which in their day did—

Fill the world with dread,
Were much admired,
And but little read,—

for they are old chemistries—that's all! which gradually have grown in number. Tho' seared their leaves, crude their bindings,—often dreadfully worn and decayed,—they recall as do old, old letters of love and story—that

> through those manifold, twinkling, sparkling pages something of the past beckons us, whispers us, delights us, and above all in the magic phrase of Keats, "teases us out of thought, as doth eternity;

and I continue to dream—dream as to the manner of men who wrote the books, the ideas animating them at the moment, and how their efforts, on coming from the press, were talked about in scientific coteries. Such and hundreds of other thoughts are evoked, and quite willingly and promptly would I share them with friends, but immediately the consciousness arises that in these days of action little patience is had with tales of the past. The inner urge, possessed even by scholars of the present, will not listen to a pause—to a look backward—so the dreamer sighs and murmurs, with a sigh—what a pity! when the past is replete with so much of interest and, if it must be, also of practical value. Indeed, the *fathers* were practical. They knew much, if moderns would but recognize it, that would be helpful in the present moment.

But I must drop this gentle scolding humour, and call attention to a few—a very few—of the ancient chemical volumes reposing in dignity on the shelves of my old book case! First, there is *Alchemiae Geberi Arabis philosophi solertissimio, Libri cum Reliquis, ut versa pagella indicabit*, published at Nuremberg in 1545—nearly four hundred years ago! Its contents command attention. Some chemist, long ago, must have studied this particular copy of the book very intently for the marginal comments and corrections in ink are numerous. Like many chemical historians of the present, this chemical scholar had a keen interest in Geber. Did Geber live or was he a myth? Most recent investigation favors his actual existence, tho' it does not credit him with all the writings generally attributed to him.

The volume in hand contains among others:

Liber I. Gebri, De investigatione perfectionis metallor.
Liber II. Summae perfectionis metallorum, siue perfecti magisterii.
Liber I. Eiusdem de inuentione ueritatis seu perfectionis metallorum.
Liber I. De Fornacibus construendis.

My copy is small quarto in form. The type is clear and distinct. The woodcut illustrations of furnaces and apparatus for distillation are unique and attractive. If this volume were translated would it have many readers? And, I continue to dream, while my hand goes searching along the volumes on the shelves until arrested by a tall volume bound in vellum. It is by Lazarus Ercker, relates to metals, their ores and treatment of the latter. It is metallurgic in character. It appeared in 1598 in its German dress. Fond of pictures and prints, I have spent hours in the study of its many illustrations—curious old woodcuts. There are several representing the washing of gold ores. They are very crude. They delineate men earnestly pushing forward their labors, conscious of the value of the material upon which they were engaged. Naturally, the forms of apparatus are cumbersome and primitive. But they tell their story and one may readily read backwards from our present high place in the metallurgy of the noblest of metals to the period of the humble beginnings depicted in these old, rough woodcuts, which acquire genuine beauty on study! There is, further, a conclusion to this intensely fascinating publication which is slowly grasped in these days. It is a recognition that the metals and their ores are God's gifts to man. In short, it is a prayer of thanksgiving and gratitude. It is rather lengthy, and almost identical with the expression

Deo T. O. Mundi, Laus et Honor,

found at the conclusion of Brendel's *Chemistry* published in 1670 and in many other volumes of early date dealing with chemistry, and also with those devoted to legal matters. Similar expressions, such as

Deo Gloria
Sit nomen Domini
Benedictum

are observed at the close of many ancient volumes on chemistry. Do such devout expressions warrant the idea that chemists of past centuries were genuinely more reverent and God-fearing than their modern representatives? This thought has intruded itself while dreamily scanning the pages of Jean Beguin's *Tyrocinium Chymicum*—1643. A very popular text this must have been for on the fly-leaf of my copy an unknown scholar wrote—

this book passed through no fewer than 53 editions.

A best-seller more than 280 years ago! It must have been in that class of publications, otherwise why so many editions? And it is, of course, written in Latin. Besides the usual pharmaceutical preparations of such early publications, it describes substances intended primarily for chemical use and outlines plans for a chemical laboratory. Such are some of its attractions.

And next there looms up a stately volume, also in Latin, easily read by persons who, in college days, occupied themselves with the customary standard authors, such as—Virgil, Horace, et al. It is the third volume of Andreas Libavius' exhaustive treatise. It appeared in 1611. Its title is

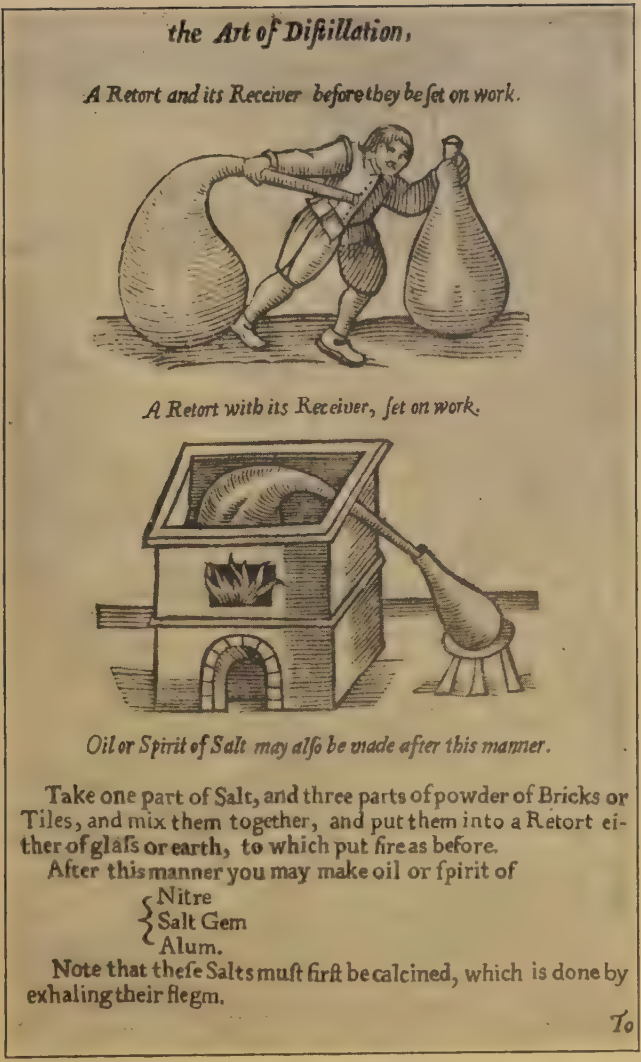
> Syntagma Selectorum undiquaque et Perspicue traditorum Alchymiae Arcanorum.

And it aims to present everything known, pertaining to chemistry. The title page is richly illustrated. An examination of the wonderful pictures on it is inspiring. They are hints as to the probable discussions subsequently set forth upon its pages. In a seminar such a contribution would call forth an abundance of opinions and contribute to a disclosure of their merit. Again, it may be remarked there is an elegant and to all appearances most satisfactory index, while the closing sentence in the copy before me reads:

> Deo uni & trino soli Gloria, honor & benedictio in aeternum.

Space precludes the mention of other delightful books; it is difficult to turn from them; so, even at the risk of wearying the reader for a little while, mention will be made, first, of John French's "Art of Distillation," London, 1653, which was printed for *Thomas Williams* at the Sign of the *Bible* in Little-britain without Aldersgate. It introduces and emphasizes another chapter in early chemical work—the extraction of valuable substances through distillatory processes. Furnaces hold a secondary place, which informs the student that a new chapter in ancient investigation was being introduced. There occur, also, curious statements in the preface, one of which reads:

> As long as I have sense or reason, I shall improve them to the honour of Art, especially that of Alchymie. In the perfection thereof there are riches, honour, health and length of days; by it *Artesius* lived 1000 years. Flammell built 28 hospitals with large revenues to them, besides Churches and Chappels; for it, both they and divers more were accounted Philosophers, and wise men, which sounds more honourable in my ears, than all the ratling and empty titles of honour whatsoever besides. In the perfection of this Art, I mean the accomplishing of the Elixer, is the Sulphur of Philosophers set at liberty, which gratifies the releasers thereof with three kingdoms, viz.: Vegetable, Animall, and Minerall, and what cannot they do, and how honourable are they, that have the command of these? They may command



the *Art of Diſtillation,*

A Retort and its Receiver before they be ſet on work.

A Retort with its Receiver, ſet on work.

Oil or Spirit of Salt may alſo be made after this manner.

Take one part of Salt, and three parts of powder of Bricks or Tiles, and mix them together, and put them into a Retort either of glaſs or earth, to which put fire as before.

After this manner you may make oil or ſpirit of

{ Nitre
{ Salt Gem
{ Alum.

Note that theſe Salts muſt firſt be calcined, which is done by exhaling their flegm.

To

The art of distillation.

Face p. 4

Lead into Gold, drying plants into fruitfulnesse, the sick into health, old age into youth, darknesse into light, and what not? A month would fail to give you an account of their power and dominations. Now for the effecting of this I shall besides what I have advised in the Epistle to the Reader, say only this: Court the Mother, and you winne the Daughter, prevail with Nature, and the fair Diana of the Philosophers is at your service.

Most surprising are the forms of distillation apparatus exhibited in the rough wood-cuts dispersed throughout the text.

The accompanying picture may cause a smile.

The succeeding illustration shows that the fathers were not unmindful of the power of old Sol's heat.

And as a second example of volumes devoted more particularly to special chapters in early chemistry is the "*Cours de Chymie*" by de P. Thibaut, printed at Paris in 1667. He announced himself as "distiller in ordinary to the King" and delighted in this high sounding title. As a tribute to his course in "Chymie" an admirer, one Jacquet, wrote the following sonnet, which is taken from the old book:

Royal Distillateur de tous les Vegetaux,
Qui tire de leurs Corps l'eau, le sel, le Mercure
En les rendant si purs qu'ils changent la Nature,
Et prolongent la vie au Roy des animaux.

Ton Art produit au jour l'Ame des Mineraux,
Qui donne aux Clairs Cristaux l'admirable teinture,
La Lune avec Venus fait une Creature
Mariant sa Beauté au Prince des Metaux.

Grands Filous, Charlattans & Sousseurs d'Alchymie
De qui la Verité est toujours ennemie,
Cassez vos Alembics, abbatez vos Fourneaux.

Thibaut nous fait tout voir par son experience,
Enseignant aux humains la divine Science,
De se rendre Immortels par l'eau de ses Tonneaux.

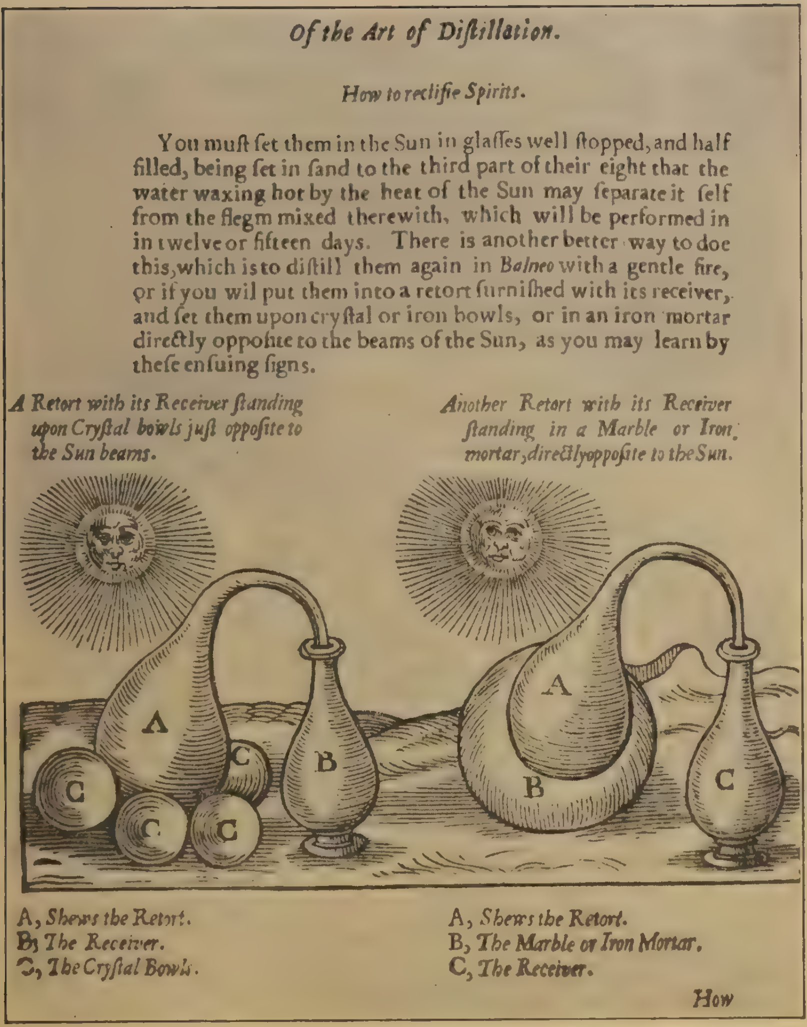
The "De L'Elaboratoire Chymique" as set forth in the book is especially attractive. According to it three conditions are imperative for a laboratory. It must be a place large enough for all possible operations. It must be provided with means of eliminating "smokes and disagreeable or dangerous odors." There must be space sufficient for furnaces, for large glassware and an abundance of it, also an auditorium. There were then audiences to whom Thibaut and kindred spirits must have lectured on their specialties. The outside world was being taken into the confidence of the "philosophers." Quite properly there is given a pretty accurate description of chemical furnaces, as well as the forms and applications of the glassware. Thibaut, in several places, refers to the necessity for an abundance of glass apparatus, much of which was used in distilling and rectifying liquids of the greatest variety. Another feature is that after giving a description of a substance, explanatory notes are added.

The book lacks the spiritual dedication noted in so many others of its period. Could Thibaut have been a bit of a heathen?

I have also had very considerable interest in "A Compleat *Course of Chymistry*, by George Wilson, Chymist, printed in London in 1709, at the *Judges-Head* in *Chancery-lane*." It is a very readable book; and appearing as it did so early in the eighteenth Century it reveals the gradual changes and progress in the science—its aims and purposes, as well as its uses.

In the preface Wilson observed:

> I shall not entertain the *Reader* with an *Encomium* on the usefulness of *Chymistry;* or stop him here whilst I ennumerate the many great improvements in other Arts and Sciences which are owing to it; this has been done by many abler pens than mine.
>
> Yet I cannot but take notice, that from hence our Modern *Physicians* have the greatest and (I would persuade myself) the best part of their *Materia Medica;* for I find the use of *Chymical Medicines* daily increase, by the constant Approbation of the most Learned in that noble Faculty; so that now there are very few noted Simples, either in the *Mineral, Vegetable* or *Animal Kingdom,* but what have received some advantage by *Chymistry;* and we may reasonably expect frequent discoveries to the Benefit of Mankind, since *Nature* herself is the capacious and fertile subject of our *Art.* But to give some account of this Book, especially of this *Third Edition;* you will find some



Of the Art of Diſtillation.

How to rectifie Spirits.

You muſt ſet them in the Sun in glaſſes well ſtopped, and half filled, being ſet in ſand to the third part of their eight that the water waxing hot by the heat of the Sun may ſeparate it ſelf from the flegm mixed therewith, which will be performed in in twelve or fifteen days. There is another better way to doe this, which is to diſtill them again in *Balneo* with a gentle fire, or if you wil put them into a retort furniſhed with its receiver, and ſet them upon cryſtal or iron bowls, or in an iron mortar directly oppoſite to the beams of the Sun, as you may learn by theſe enſuing ſigns.

A Retort with its Receiver ſtanding upon Cryſtal bowls juſt oppoſite to the Sun beams.

Another Retort with its Receiver ſtanding in a Marble or Iron mortar, directly oppoſite to the Sun.

A, *Shews the Retort.*
B, *The Receiver.*
C, *The Cryſtal Bowls.*

A, *Shews the Retort.*
B, *The Marble or Iron Mortar.*
C, *The Receiver.*

How

Of the art of distillation.

F. Knight del.
M. Vr Gucht Sculp.
George Wilson
Ætat: Suæ 78: Anº Domni MDCCIX

George Wilson.

Face p. 6

processes common to all Operators, and these I have made use of as things necessary to my Design, but even these I have much Improved, and have annexed to them many new observations concerning the way and manner of working them, which I have found not only convenient, but by the experience of more than fifty years sometimes absolutely necessary.

To this *Edition* I have added above forty Preparations, and carefully corrected and Enlarged the former; . . . I have thro' the whole studied *Brevity*, and therefore I have rejected not only the frivolus and useless Trifles of other Chymical Authors, and also have declined Mons. Lemery's pompous way of Philosophyzing upon the Processes. Neither was it my business to criticize upon that celebrated Author; but let the judicious Reader compare our Methods of working the same Subject, and he will in some things find a wide Difference, which I am content shall be put to the test of Practice, and then you will soon determine who is in the right.

My Stile is intelligible, and that I think, in relating Matters of Fact, is sufficient; some particular Expressions, as *fill half full*, &c. will I hope be pardon'd, for Dress and Ornament have not been my Care.

As long as God shall give me Health, I shall continue to divert myself in the Laboratory; and what useful Appearances occur I shall faithfully communicate; for I endeavour all I can, in my way, to be truly serviceable to the Public.

No doubt the reader will consider, as does the writer, that this preface is very suggestive. The early chemical writers were human and it is exactly the expression of this humanness which renders their writings delightful and clearly shows the slow growth of the Science even when its adepts were most attentive to it.

The table of apparatus from Wilson's text is here introduced because it aids, as a picture of the methods of work in which he was so diligently engaged.

Another text deserves presentation. It is termed *Historie de la Philosophie Hermetique* by the Abbé Lenglet du Fresnoy. It comprises three volumes printed in 1742 in Paris. There may be readers who will wish to extend their studies among alchemical writings; and to them these books will be a safe, reliable guide. Their author was born in 1674 and died in 1755. While apparently accepting the truth of the legends relating to the great antiquity of alchemy and narrating accounts of veritable transmutations at considerable length, du Fresnoy at the same time exposes the frauds practiced by the adepts and quotes entire the celebrated essay of Goeffroy: "Des Supercheries concernant la Pierre Philosophale," which rang the death knell of the Hermetic Art.

The first volume of the work contains only historical matter. In this chronology, which begins with "Hermes, 1996 B.C." there are included Moses, Cleopatra and Caligula. The second volume continues the history. The third volume is devoted to bibliography. Lenglet's comments are interesting and sometimes amusing. This bibliography is the best published to that date.

Nicolaus Lenglet du Fresnoy
né à Paris
le 5. Octobre 1674.
Le tems de qui Lenglet malgré d'épaisses ombres
Retrouve tous les pas, qu'il montre à nos Esprits,
Le tems sur ses doctes écrits
Ne laissera jamais tomber ses voiles sombres.
L. C. D. Neufvilles
à Paris chés Petit ruë S.t Jacques près les Mathurins

Nicolas Lenglet du Fresnoy.

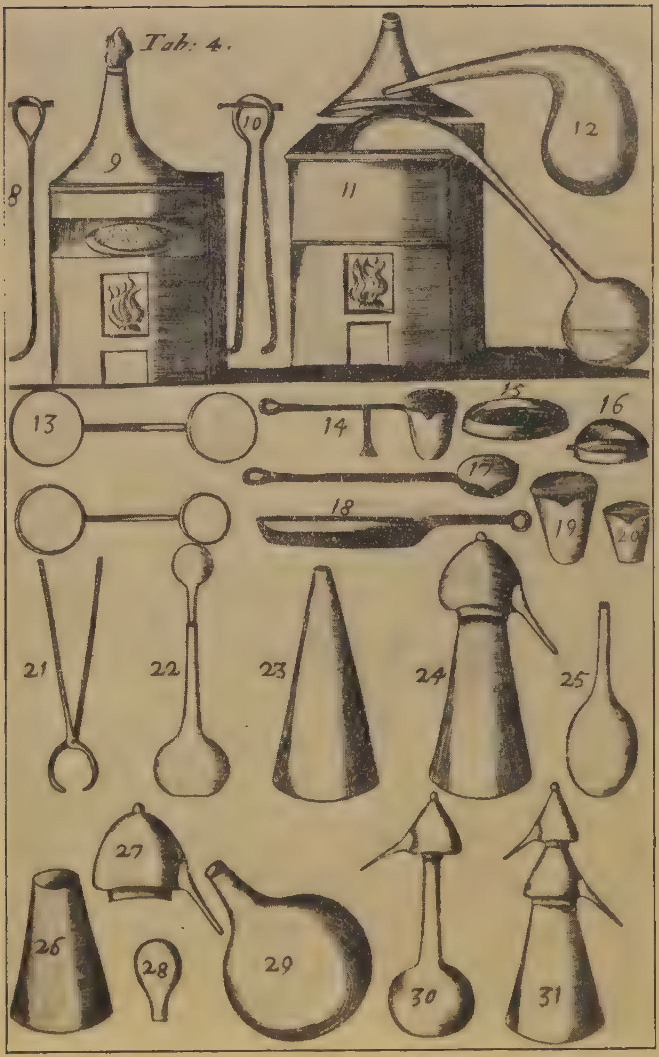
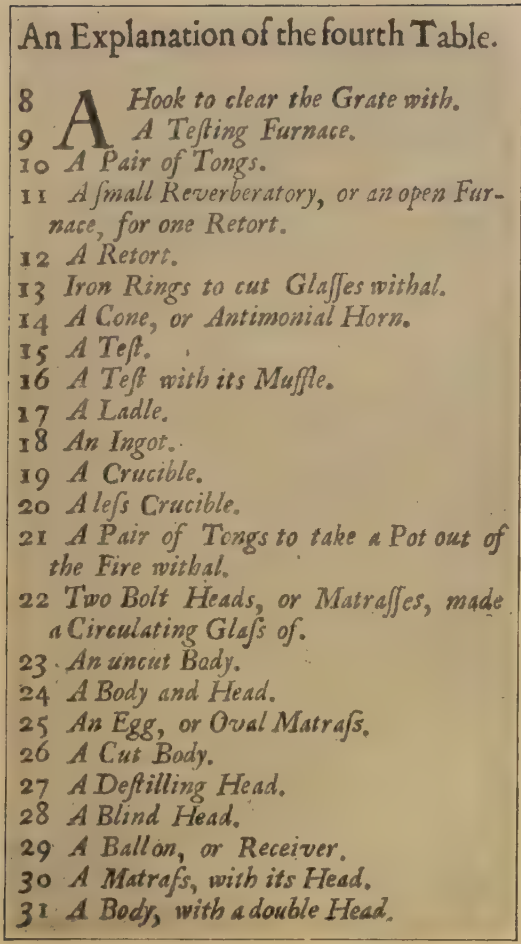


Table of apparatus.



An Explanation of the fourth Table.

8 *A Hook to clear the Grate with.*
9 *A Teſting Furnace.*
10 *A Pair of Tongs.*
11 *A ſmall Reverberatory, or an open Furnace, for one Retort.*
12 *A Retort.*
13 *Iron Rings to cut Glaſſes withal.*
14 *A Cone, or Antimonial Horn.*
15 *A Teſt.*
16 *A Teſt with its Muffle.*
17 *A Ladle.*
18 *An Ingot.*
19 *A Crucible.*
20 *A leſs Crucible.*
21 *A Pair of Tongs to take a Pot out of the Fire withal.*
22 *Two Bolt Heads, or Matraſſes, made a Circulating Glaſs of.*
23 *An uncut Body.*
24 *A Body and Head.*
25 *An Egg, or Oval Matraſs.*
26 *A Cut Body.*
27 *A Deſtilling Head.*
28 *A Blind Head.*
29 *A Ballon, or Receiver.*
30 *A Matraſs, with its Head.*
31 *A Body, with a double Head.*

An explanation of the Fourth Table.

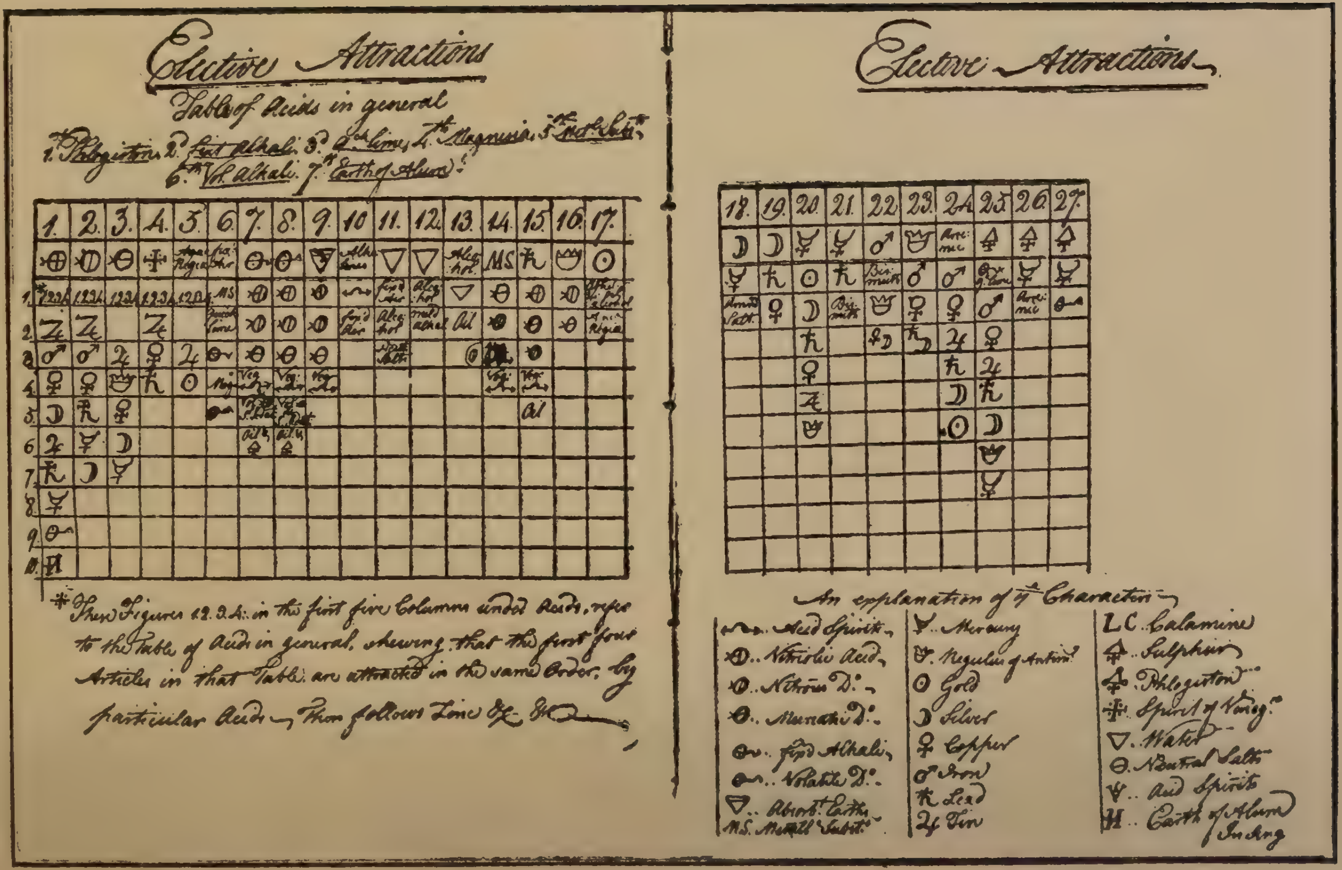
Face p. 8

CHAPTER II

VOLUMES could be filled with descriptive accounts of the early chemical literature spread about me. My real purpose at first, however, was to bring to the attention of American chemists in particular a story of chemical books used for instructional purposes in the infancy of our country. It is well established that the science then drew to itself many inquirers. Books on chemistry in old, private libraries and in the libraries of our oldest colleges and universities attest this assertion. It seemed, therefore, at least interesting to assemble as many of them as possible and re-introduce them (if that be the word) to chemical students of the present day. Again, this gathering in of the literature has afforded the writer genuine pleasure. He is very thankful that he was prompted to pursue the idea. More and more has the impression been borne in upon him that the American Fathers of Chemistry had an interest in their science equal to that exhibited by any of its modern disciples. They presented it as it appeared to them, and there is no tangible evidence that unusual efforts were put forth to minimize difficulties and to emphasize "interesting things." Again, the student of these early texts will be keen to note what foreign influence prevailed in the teaching of chemistry to his ancestors. It will gradually dawn upon him.

However, let me begin the presentation of some of the texts at hand. They are numerous, but only those which commanded unusual attention will be considered. This plan may spur others to seek additional literature of kindred character. May this happen!

To plunge in *medias res* be it remarked that in searching through neglected literature in the library of the University of Pennsylvania a set of Manuscript lectures on chemistry dating about 1760 was found. Probably they were prepared by William



Elective Attractions

Table of Acids in general

1st Phlogiston. 2d fixt Alkali. 3d Q. Lime. 4th Magnesia. 5th Metl. Subs.
6th Vol. alkali. 7th Earth of Alum.

* These Figures 1.2.3.4. in the first five Columns under Acids, refer to the Table of Acids in general, shewing that the first four Articles in that Table are attracted in the same Order, by particular Acids — then follows Lime &c. &c.

Elective Attractions

An explanation of ye Characters

Acid Spirits
Nitrolic Acid
Nitrous Do.
Muriatic Do.
fixd Alkali
Volatile Do.
Absorbt. Earths
M.S. Metall. Substces.

☿ Mercury
♁ Regulus of Antim.
☉ Gold
☽ Silver
♀ Copper
♂ Iron
♄ Lead
♃ Tin

L C Calamine
Sulphur
Phlogiston
Spirit of Vinegr.
▽ Water
⊖ Neutral Salts
Acid Spirits
Earth of Alum for Sucking

Smith, first Provost of the University—at least, in the oldest catalogues of the institution he is credited with the teaching of that science to the Senior class in the College. A page from this manuscript volume is here shown.

The American student world was still enthralled in phlogistic and alchemical ideas.

BENJAMIN RUSH

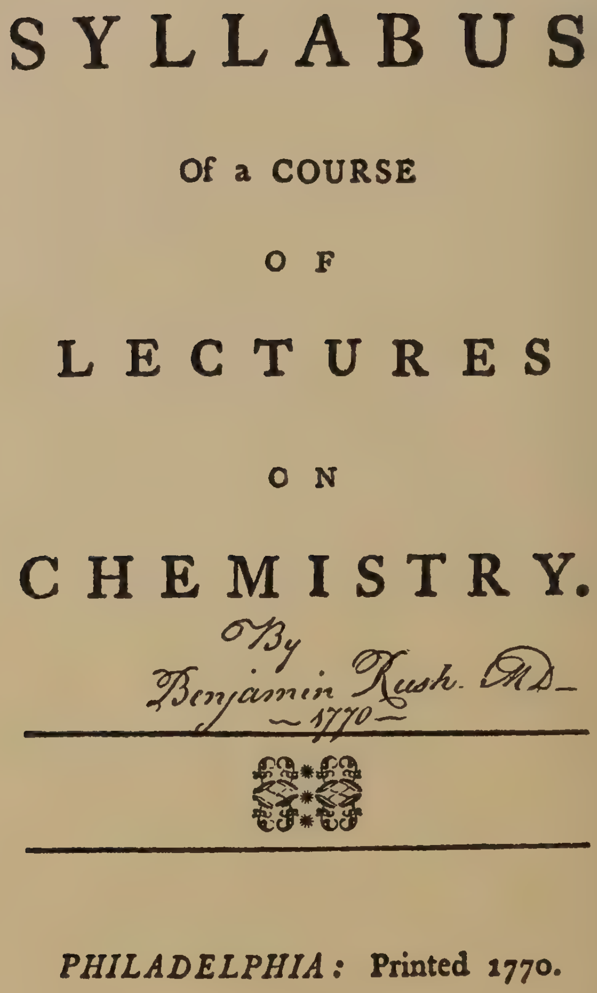
Signer of the Declaration of Independence

The first chair of chemistry, as a subject apart from related sciences, was established in the University of Pennsylvania in 1769. Rush, trained in medicine at Edinburgh, receiving his instruction in chemistry from Joseph Black—was the first incumbent of this chair. Americans are deeply indebted to Rush because of the importance he assigned to chemistry, and because through his long career he inspired many of his ablest pupils to such a degree that their lives were devoted to its cultivation; notably James Woodhouse and Adam Seybert.

His *Syllabus* was the first textual contribution in chemistry from the hand of an American. It presents the science in the main as it was in that far-away day. Several subsequent editions were published, designed for "the use of the students of Medicine in the College of Philadelphia." It had a long life and guided hundreds of ambitious young men through the labyrinthine paths of the Black Art. It must not be forgotten that it was only a *Syllabus*, but one acquainted with Rush's medical writings will readily understand that in actual teaching this skeleton—the Syllabus—was enriched and supplemented with Rush's personal knowledge and experience, so that his book constituted an important part in the laying of a broad and deep foundation for Chemistry in America.

The following abstracts are interesting. In addressing (1768) Dr. John Morgan, founder of the Medical School of the University of Pennsylvania, Rush, then in Edinburgh wrote:

> I thank you for the pains you have taken to secure me the Professorship of Chemistry. I think I am now master of the science, and could teach it



SYLLABUS

Of a COURSE

OF

LECTURES

ON

CHEMISTRY.

By
Benjamin Rush. M.D.
~1770~

PHILADELPHIA: Printed 1770.

The Utenſils or Inſtruments of Chemiſtry are divided into three general Heads.

I. The Apparatus for producing Heat.

II. Thoſe Veſſels which are uſed to contain thoſe Subſtances on which the Operations of Chemiſtry are performed.

III. The Means of applying and regulating Heat.

I. The Means of producing Heat are by

1. Animal Bodies.
2. The Percuſſion of ſolid Bodies againſt each other.
3. Electricity.
4. The Mixture of different Bodies.
5. Fermentation.
6. The Rays of the Sun.
7. Fewel.

II. Of the Properties neceſſary to form Chemical Veſſels.

Of Glaſs Veſſels.
Of Metal Ditto.
Of Earthen Ditto.

The Form of theſe Veſſels is different, according to the Nature of the Operations we perform in them.

In

> with confidence and ease. I have attended Dr. Black for two years diligently, and have, I think, received from him a comprehensive and accurate view of the science, together with all his late improvements in Chemistry, which are of so important a nature that no man, in my opinion, can understand or teach chemistry as a science without being acquainted with them. . . . As to the experiments you speak of, there is scarcely one of them but what I have seen twice performed, either publickly or privately by Dr. Black . . . I should like to teach chemistry as a Professor, because I think I could show its application to medicine and philosophy . . . Is it necessary for me to deliver publickly an Inaugural Oration? Something must be said in favor of the advantages of Chemistry to Medicine and its usefulness to medical philosophy, as the people of our Country in general are strangers to the nature and objects of the science.

Syllabus of a Course of Lectures
on Chemistry by Benjamin Rush, M.D.
Philadelphia: Printed in 1770.

HERMANN BOERHAAVE

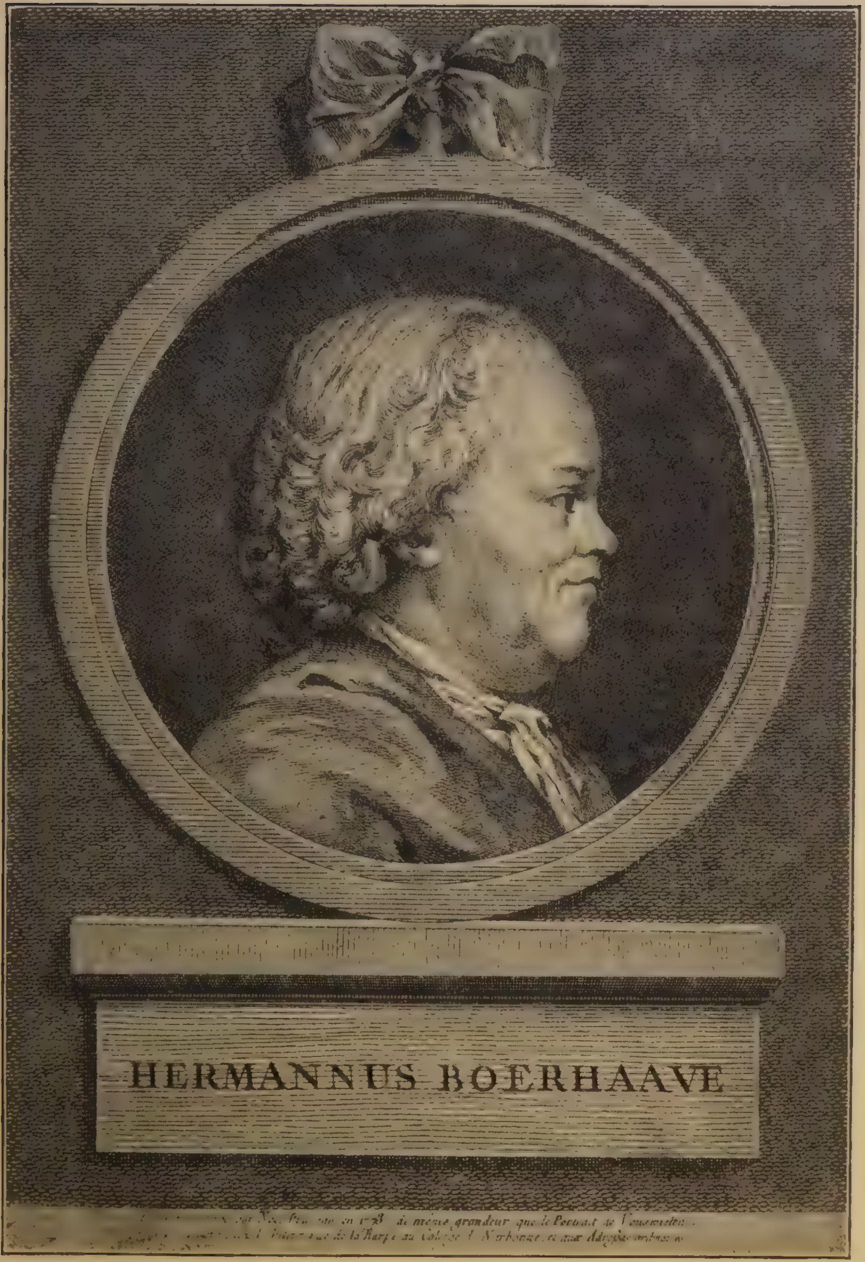
Boerhaave is a name cherished among chemists, medical men, and students of natural history. Therefore his *Elements of Chemistry* was justly esteemed by them all. The volumes, two in number, are small quarto in size. It is true, as Dallowe, one of his translators, says, Boerhaave "in many places is pretty prolix." This is quite excusable because he was addressing a very promiscuous audience,

> and it was necessary for him to dwell longer upon Things and set them in various Lights, in order to make them appear with more Evidence, and fix them upon the Mind with greater Certainty.

There was an evident necessity for Boerhaave to issue his chemistry with considerable haste because it was incumbent upon him—

> to justify himself from the monstrous Absurdities published in a Course of Chemistry with his name to it, which some of his Pupils ingenuously printed without his knowledge.

And in his own preface the Master said:



Hermann Boerhaave.

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> I have constantly had Beginners in my view; and therefore thought myself obliged to point out everything doubtful, or dangerous. For the same reason you'll find I everywhere proceed chiefly upon particular Experiments, not laying down any general Rules, without a great deal of Caution . . . In the first part of this work I had those Lectures to insert which I had given at particular times upon Chemical subjects in the publick Schools.

With all its faults it is a delightful, stimulating old book! Because of its magnitude an abridged edition was made "by a Physician"—probably Dr. Strother,—whose prefatory remarks, a bit acrid, were:

> The original of these sheets being very voluminous, and containing many superfluous Circumlocutions, contributes to raise the Price of the Book and deters the Purchasers from its perusal, but the Abridgement, I hope, has helped these Inconveniences, and yet, I can assure you, it contains the whole, except the Author's dedication, which only gives us to know how his brother from studying Physick became a Divine, and how the Author from a student of Divinity took to Physick.

Dr. Strother was evidently bent on emphasizing Boerhaave as a medical man. The minutiae of chemistry did not appeal strongly to him.

The Boerhaave *Elements* is replete with descriptive processes for the making of a variety of common chemical bodies. For example, Process CXLII outlines:

> *PURIFICATION AND CRYSTALLIZATION OF SEA-SALT*
>
> *Preparation*
>
> Dissolve sea-salt in six times its quantity of pure rain water, strain often over till it becomes clear and exhale one sixth part, let it till it settle no more, then exhale to a pellicule, set it in a cellar till it crystallizes, this is for chymical uses, thus we may exhale and crystallize till no more crystals appear; if you inspissate and let it run, this salt flies all into the air.
>
> *Its Uses*
>
> All salts crystallize into their proper forms, this salt dissolves gold, preserves meat from putrifaction, and if we mix salt with nitre and distill it proves *aqua regia.*

There is here a vast amount of information enmeshed in peculiar verbiage with, of course, errors in fact; but remember this was in the days of beginning. And in the libraries of many American homes this ancient tome held a place of deep appreciation. The writer's copy of the book, in two volumes, has upon its fly-leaf the autograph of Dr. Chovet, the most distinguished practitioner of medicine in Old Philadelphia—in Revolutionary days and in the years immediately following. All who have read the fascinating story entitled "The Red City" by Weir Mitchell, will recall the masterful manner of Aunt Gainor Wynne in the treatment of the tardy Dr. Chovet. An illustration of this female's ire, as set forth in the "Red City" provokes merriment. But how delightful Aunt Gainor was to Hugh Wynne and his set!

Again, Boerhaave, although considered one of the world's greatest exponents of chemistry, was strenuously opposed to letting the public so consider him. He believed there were many great lights—greater by far than he and others of his day—so he refers with genuine humility to these leaders as the "top-masters of chemistry."

A very delightful and appreciative sketch of Boerhaave was written by the immortal Dr. Samuel Johnson. It appeared in the *Gentleman's Magazine* for 1739.

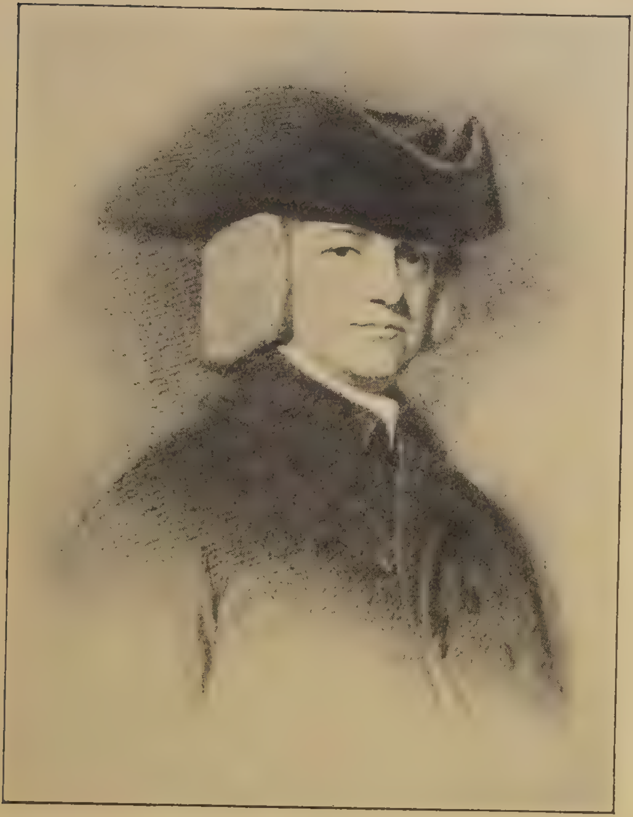
—Elements of Chemistry: Being the annual lectures of Hermann Boerhaave, M.D.—formerly professor of Chemistry and Botany, and at present professor of Physick in the University of Leyden. Translated from the original Latin, by Timothy Dallowe, M.D. London, 1735.

RICHARD WATSON

Bishop of Llandaff

The Bishop published thirty-six Essays, comprised in four duodecimo volumes. They are not a textbook—not at all, but represent a sincere effort to disseminate a knowledge of chemistry in such form as to arrest the attention of people in all walks of life. In telling of the impression chemistry made upon men of rank, fortune and ability, the author remarks

> as public men, they consider its cultivation as one of the most certain means of bringing to their utmost perfection, the manufactures of their country.



Richard Watson.

Watson was Professor of Divinity in Cambridge University. His training had been in the humanities, but when in 1762 he was chosen Professor of Chemistry in that University—though wholly ignorant of the science—he

> immediately sent to Paris for an operator, buried myself in my laboratory, and having, in October 1765 been a fourth time elected moderator, in fourteen months from my election I read a course of chemical lectures in the University, to a very full audience.

His "Chemical Essays"—1781—contributed greatly to the popularization of the science. This pleased him. He took pride in the fact that he

> had endeavoured to contribute a little towards its establishment among us.

Then comes the following lovely confession:

> I hope the utility of the design will plead my excuse with those who, in the severity of their judgments, may think that I have contributed more than, from the nature of my Profession and situation, I ought to have done. When I was elected Professor of Divinity in 1771, I determined to abandon forever the Study of Chemistry, and I did abandon it for several years: but the *veteris vestigia flammae* still continued to delight me, and at length seduced me from my purpose. When I was made a Bishop in 1782, I again determined to quit my favourite pursuit; the volume which I now offer to the public is sad proof of the imbecility of my resolution. I have on this day, however, offered a sacrifice to other people's notions, I confess, rather than to my own opinion of *Episcopal Decorum*—I have destroyed all my chemical Manuscripts.

It is most regrettable that the author of the "Essays" should have so determinedly turned aside from the science, which he ably assisted in winning a permanent hold on English soil.

The "Essays" extensively read thro the Colonies has its counterpart, at present, in the "Marvels" and the "Revolutions in Chemistry." Thus the exemplar, lying at the writer's side, has on the title page, in ink, the name of Charlotte Johnson. Who she may have been is not to say; suffice that she evidently was a refined and intelligent representative of the United States in their earliest infancy.

Mention is made of the "Essays" as influencing chemical thought in this country because copies of the publication have been found in many old American home libraries. Then, too, Bishop Watson—for he was the Bishop of Llandaff—was most friendly to the American Colonies. In 1776 he published a University sermon entitled: The Principles of the Revolution Vindicated. He was very hostile to those who entered war with America and opposed a University address to the King, urging him to continue the war. The Bishop was a man of independent thought and one of the greatest men of his day.

The "Essays" passed through a number of editions. These it was which reached American shores, and one can well surmise their effect upon students of chemistry in the last quarter of the 18th Century. They are not in the least tiresome in the reading; on the contrary, they breathe out the spirit of an unusually well informed student, possessing the ability to present his material in broad, attractive form, which may well explain the comment of Sir Humphry Davy that

> he could scarcely imagine a time in which they would be superannuated. De Quincey's Works. *II*, 106.
> —*Chemical Essays* by R. Watson, D.D. F.R.S. Regius Professor of Divinity in Cambridge. London. 1781.

The next volume is unique. Tradition tells that it was much sought after. Real chemists used it and in their various writings frequently referred to it. In reality, it was a layman's volume. It was prepared in a patriotic spirit and bore the title—*Chemical and Economical Essays.*

CHEMICAL
AND
ECONOMICAL ESSAYS

Designed to Illustrate

THE CONNECTION BETWEEN THE THEORY
AND PRACTICE OF CHEMISTRY, AND THE
APPLICATION OF THAT SCIENCE TO
SOME OF THE ARTS AND
MANUFACTURES OF
THE
UNITED STATES OF AMERICA

"It is a pity so few chemists are dyers, and so few dyers chemists."

By JOHN PENINGTON

PHILADELPHIA
PRINTED BY JOSEPH ADAMS
M,DCC,XC.

This publication of 200 pages was written by a young man who had had his attention directed to chemistry by someone previously impressed with its value. Penington, accordingly, became enthusiastic upon the subject, dedicating his work (which was written when he was twenty-two years of age) to

> CASPAR WISTAR, JUNIOR, M. D.
> AND
> PROFESSOR OF CHEMISTRY
> in the College of
> PHILADELPHIA,
> The Friend and Patron of
> CHEMICAL INQUIRIES IN AMERICA,
> These Essays are inscribed, by
> His sincere friend
> and pupil,
> JOHN PENINGTON
>
> Philadelphia,
> *May 25, 1790.*

The reader will pronounce this effort an appeal—an attempt—to have the laity understand some of the fundamental principles of the science. It is not a text book of descriptive chemistry, but it does emphasize the value to society of many chemical products.

Here and there occur rather amusing statements; for example:

> Chemists themselves belong to two great and distinct classes, which, it is a pity are not connected; in the one class we may rank those who perform a great number of operations by heat and mixture, without ever knowing the secondary causes of the effects produced; these are called practical chemists, such as dyers who cannot account for, or conceive why, allum, for instance, should be of use in their art; or why galls and copperas should produce a black dye; such also are tanners, who cannot explain the action of the oak bark upon the hides; such likewise are many apothecaries, who can make aqua fortis, &c., &c. but know nothing of the rationale of the process; the other class is represented by the mere theorist, who is well acquainted with the "effects of heat and mixture" upon all bodies, and can account for them all, but never soils his fingers with a piece of charcoal, or has had occasion to

break a crucible; such a chemist can inform us admirably how the changes of colour in dying are produced, but would be unable to produce them himself; he can account for the action of oak bark upon animal substances, without ever having smelt the odour of a tan-yard; he could explain the theory and process of making aqua fortis; and perhaps were he to attempt to make it, he would be two hours kindling a fire in his furnace, break his distillery apparatus, lose all his aqua fortis, and suffocate himself with the fumes. From the comparison every one will allow that the practical chemist is the most respectable character; but many worthy gentlemen of this class have contended, that theoretical chemistry could be of no use to them. This idea, however, will admit of much dispute; if we appeal to fact, we find that many of the most useful discoveries in the arts have been made by men who have combined some kind of theory with their practice.

Why is it, the chemist may well ask, that in almost every age he seems to be regarded and set forth as a peculiar individual? Present day chemists would find in Penington's book the earnestness they themselves show in exhibiting the nearness of chemistry to society. There is every indication that this pioneer publication was widely read in intelligent and refined circles, where it made a very happy impression.

After writing the volume, Penington studied in Europe, and on his return gave much attention to the promulgation of the science, so that it is a pity he was stricken down by yellow fever in 1793. He gave promise of doing well in his avocation—chemistry. Perhaps it would not be unfair to say that the spirit that animated him in the production of these *Chemical Essays* was the same as that which has animated not a few chemists in recent times in their efforts to popularize their science.

A. F. FOURCROY

The Elements of Chemistry by Fourcroy, an exhaustive work, first appeared in 1780. It had a rapid sale. The third edition had been translated by Heron, who gladly embraced the opportunity of issuing a fourth edition (1796) in English, much revised and improved. It is noteworthy that he dedicated his translation to Dr. Joseph Black, who said he

> honoured it with his recommendation to all students of chemistry.

And Heron believing—

> that the physical sciences ought not to reject the advantages of purity, perspicuity, and precision of style, any more than the moral sciences and the fine arts,

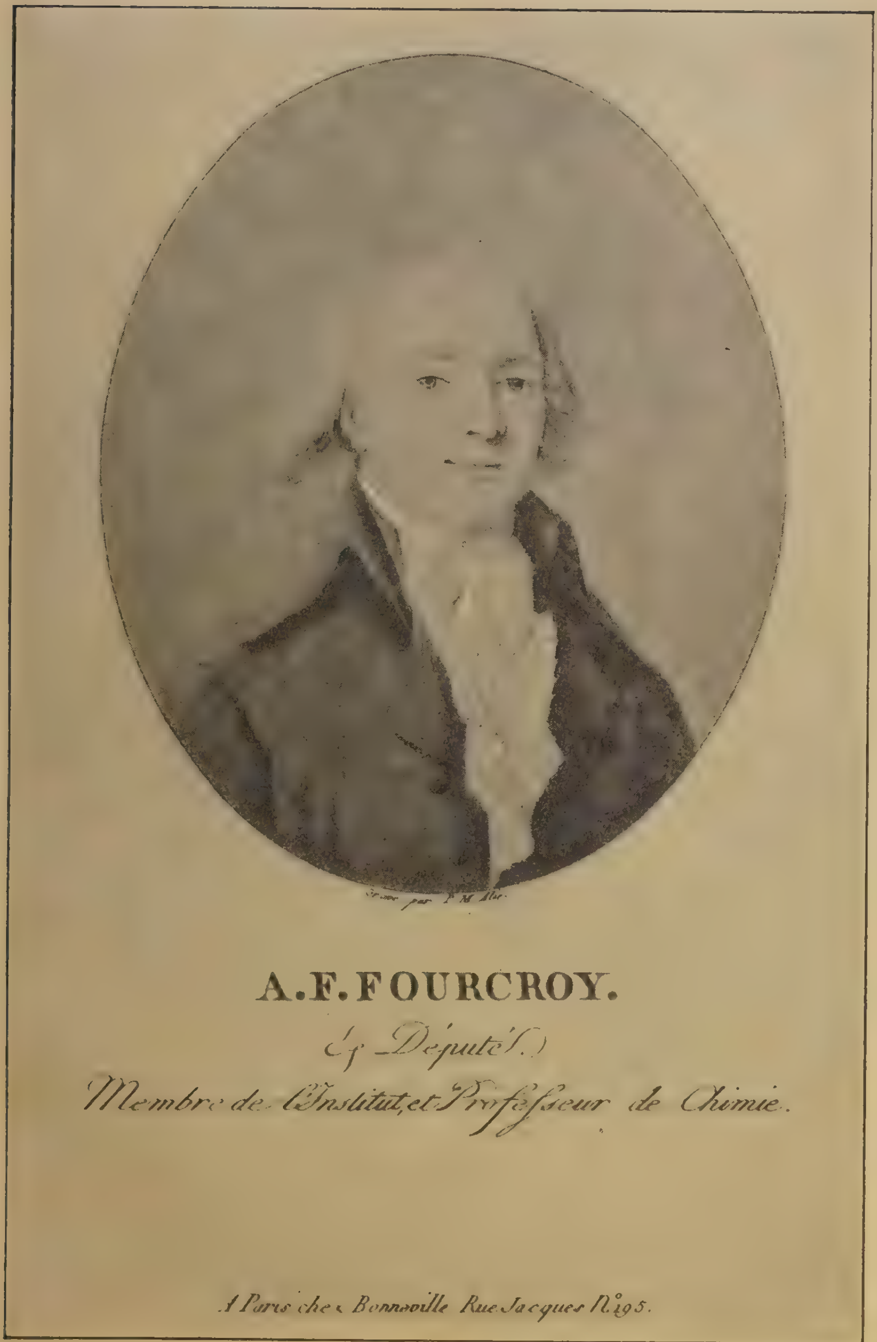
admits in his translation that he labored

> at once to make Fourcroy speak pure, perspicuous, intelligible English; and to preserve strictly the propriety, the peculiar phraseology of the science, and of the new theory.

The new theory was the anti-phlogistic theory, and Fourcroy in this fourth edition wrote:

> My opinion is still more strongly expressed in favour of the pneumatic theory—or, the anti-phlogistic theory, because I am still more entirely convinced of its truth . . . This theory takes nothing upon supposition, admits no hypothetic principles, and consists only in a fair detail of facts . . . The modern *theory of chemistry* . . . which denies the existence of phlogiston, is daily gaining more converts; and is already so generally received, that three fourths of the students, and especially of the teachers of chemistry, may now be reckoned among its adherents. The two most eminent chemists in Europe, Dr. Black and Mr. Kirwan, after examining, with the utmost care, the new principles of the French chemist, and after contending against them for the space of ten years, have, at last, with the candour becoming men of real genius and enlarged minds, frankly adopted them. For on the 26th of January, 1796, Mr. Kirwan wrote to M. Berthollet: "At last I lay down my arms, and abandon the cause of phlogiston. I clearly see, that there is no unequivocal experiment to prove the production of fixed air from pure inflammable air. This being so, it is impossible to maintain the doctrine of phlogiston with respect to metals, sulphur, etc. Without decisive experiments we cannot form a system, in opposition to positive facts. I shall compose a refutation of my own essay on phlogiston."

It will be recalled that Kirwan was a devoted friend of Joseph Priestley, and had courageously supported his enthusiastic advocacy of phlogiston. This letter and the one which follows must have meant a very great deal to young American chemists, particularly James Woodhouse who so earnestly opposed the phlogiston notions of Priestley, endeavoring with all his experimental skill to counteract the same. To him and others this



Gravé par P. M. Alix.

A.F. FOURCROY.

(Ex Député.)

Membre de l'Institut, et Professeur de Chimie.

A Paris chez Bonnoville Rue Jacques N.º 195.

A. F. Fourcroy.

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conversion of Kirwan came through the study of Fourcroy's book, either in its translation or perhaps in its original French. And the letter of Joseph Black also gave them thought and courage to proceed under the *new theory*. The letter was addressed to Lavoisier. It read:

> You have been informed of my endeavoring to explain to my pupils the facts and principles of the new system which you have been so fortunate as to discover, and which I begin to recommend, as being more simple, more uniform, and more consistent with facts, than the old theory. And how could I do otherwise? The many skillful experiments which you have made in the great way, have been prosecuted through all their changing phenomena with such assiduous care, and such scrupulous attention, that nothing can be more satisfactory than the proofs to which they have conducted you. The system which you have founded upon your facts, is so closely connected with them, so simple, and so easily intelligible, that it must daily obtain increasing approbation; and cannot fail to be adopted by a great many chemists who have long been accustumed to the old system. You must not hope to convince every person. You will know that habit enslaves the minds of most men, and makes them believe and reverence the greatest absurdities. I must confess to you, I myself have felt its influence. Having been accustomed for thirty years to believe and teach the doctrine of Phlogiston, as it was understood before the discovery of your system, I long felt a degree of dislike to the new system, which represented that as an absurdity, which I had regarded as scientific truth. But that dislike, as it arose only from the force of habit, has been gradually diminished and overcome by the clearness of your demonstration and the solidity of your plan, although there be still some particular facts of which the explanation seems difficult, and scarce satisfactory; I am, however, convinced that your doctrine is infinitely better founded than the old theory, and in this respect, cannot suffer by a comparison with it. But if the power of habit still hinder some old chemists from approving your ideas, the *young* cannot be *influenced* by the same circumstance: they will universally rank themselves on your side. We have experience of this in our University, in which students enjoy the fullest liberty in the choice of their scientific opinions. They, in general, embrace your system, and begin to use the new nomenclature.

The student of the history of chemistry will welcome these letters. They clear up unsettled points—unsettled in the sense that chemists of that period were given the conclusions of leaders to whom they had been looking for guidance. The Edinburgh school greatly influenced American chemical students.

It was declared (1796) that

> in opposition to twelve or fifteen chemists, in all Europe, who still refuse to admit this doctrine, there are more than fifty eminent professors and votaries of physical science, who make it the basis of their writings and lectures.

When Fourcroy wrote those last lines he, evidently, was not thinking of a group of young American chemists who were heroically advocating the "new theory". He may have regarded them —if he gave them any thought—as mere students, which they were, but in addition they experimented, and backed by experimental facts declared their faith in the French doctrine. But some would not hear. Probably they felt happier in the company of the distinguished Baumé, Monnet and others of equal rank, who diligently presented "warm objections . . . to the pneumatic chemistry."

The advocacy of the antiphlogistic theory by Fourcroy in 1796, was genuine—sincere beyond every doubt, yet, two years before, in 1794, the great framer of the pneumatic doctrine was guillotined, largely through the relentless fury of Fourcroy, whose object was to crush Lavoisier. Human nature is difficult to fathom! In 1787, and several years preceding, Fourcroy and Lavoisier, with de Morveau and Berthollet had labored devotedly, in almost fraternal relations, to purge the nomenclature of chemistry from its cumbersome, mythical terms, and strove to arrange and systematize facts so that order might indeed emerge from the chaos of centuries long gone. These two men also contributed to the advancement of chemistry along many other lines, so that it is almost incomprehensible to grasp Fourcroy's attitude toward his colleague; and in perusing his admirable text, letting the events of that momentous period in French history hover about one, the problem grows even more complex. The admission of Lavoisier's genius is evident on page after page, and one continues to wonder!

The entire text of Fourcroy is refreshing. There is in it, as in the memorable texts of Bergmann and Boerhaave, an historical section, which Lavoisier omitted from his classic volume, probably because he was so engrossed with the newer things and frantically eager to lay them before an expectant chemical public. But, with Fourcroy there was a reverential regard for the efforts of his predecessors, which he manifests in a succinct chapter, referring all

> desirous of fuller information concerning the rise and progress of chemistry

to the treatise of Olaus Borrichius, the Dictionnaire Encyclopedique, Senac's Treatise on Chemistry, du Fresnoy's History of the Hermetic Philosophy, Macquer's Chemical Dictionary, Bergmann's History of Chemistry, etc., etc.

One reads Fourcroy's historical epitome with pleasure. In the paragraph devoted to alchemists Americans will meet—

> . . . Thomas Vaughan, born in England in 1612. He went to America where Starkey saw and received gold from him. Boyle corresponded with him. This is the same adept who, in France, gave the powder of projection to Helvetius . . .

The Starkey here mentioned is George Starkey, a devoted transmuter, "a Philosopher of Fire, entitled by himself," and an alumnus of Harvard, who spent the greater part of his life in London "in a house in St. Thomas Apostle's, next door to Black Lion Court."

The applications of chemistry receive very full consideration. How can such knowledge as chemistry gives man be applied to his welfare, comfort and happiness is a very old question. The earlier, exhaustive works on chemistry are replete with such thoughts. As observed by Macquer many branches of chemistry were known and practiced, but

> the science itself was not yet in existence.

It would appear that James Barner in his *Philosophy of Chemistry* was probably the first to attempt to form a complete system of chemical knowledge and to rank chemistry among the sciences. This happened back in the 17th Century.

Turning to the material incorporated by Fourcroy into his text, it will be observed that very considerable space was allotted to chemical attractions or affinities. He had been much impressed by Bergmann's ideas on this topic. Indeed, this subject commanded the thought and attention of chemists everywhere. On careful examination of our earliest texts in chemistry, one is surprised at the elaboration of this topic. Caloric, also, was a much discussed subject. Today, the following quotation causes one to think:

> There are two kinds of attraction in double elective attractions.

And what answer would one give to these interrrogatories:

> What are *quiescent* attractions?
> What are *divellent* attractions?

Common air—"an invisible, inodorous, insipid fluid possessed of gravity and elasticity"—introduces the descriptive portion of the book. Ordinarily, this section would be hurriedly passed, but if one is curiously inclined and will patiently read the lengthy discourse, the final impression will be most favorable. It will be easily recognized how our present understanding of air has been derived. That is one of the joys experienced in tracing the historic development of the science.

Combustion is most interestingly presented, and why should it not be when it was

> the elegant theory of M. Lavoisier in the years 1776 and 1777 that explained all the phenomena of combustion.

Water receives extended thought and experimental study. And, is not the next quotation more than interesting?

> M. Lavoisier having observed, with M. de la Place, that when inflammable air (hydrogen) is burnt in a close vessel, by the help of vital air (oxygen), a product of pure water is obtained (a fact which was observed at almost the same time by M. Monge, with the most accurate attention, in the laboratory of the School of Meziere), concluded that this vital product must be composed by the combination of vital air with the inflammable gas; and that these were the constituent principles.

In this conclusion there is laid before the student the basis of that experiment which promptly followed, viz., the passage of steam over heated iron filings.

> Such was the first experiment in which this enlightened chemist (Lavoisier) accomplished the decomposition of water.

And how many times has it since been performed and pronounced to be fundamental?

In subsequent chapters the Earths and Stones receive very full discussion. Minerals are given ample space. In the far-away days they were objects of concern with chemists. Acids and salts have full consideration, this section occupying more than half of the second volume. Metallic substances are shown to be very important and the observations upon them are instructive. This is particularly true in the case of antimony, mercury and zinc, and the reader will be glad to have the comments and facts come before his eyes and mind.

There are chapters devoted to vegetable substances and to those bodies which are now portions of organic chemistry. The various kinds of fermentation are discussed. Milk and blood are not omitted. There is also an examination of mineral waters, and a suggestive and remarkable discourse (in the 4th volume) on "modern chemistry in general, and on its first principles." The writer having been a teacher of chemistry and having spent his life in the study of the science would be, perhaps, in any remarks on this topic over enthusiastic—perhaps his enthusiasm would be shared by few, yet he must say that this discourse is so logically presented and clothed in such simple language that it deserves the title of *classic*.

Think of Fourcroy speaking enthusiastically on Lavoisier's theory!

> Its simplicity, its systematic progress, its perspicuity, and the ease with which it is applicable to all the phenomena of chemistry . . . Among the more celebrated of its partizans, it now boasts the names of Lagrange, La Place, Black, Kirwan, Van Marum, Berthollet, Monge, Morveau, Chaptal, Charles, Landriant, Shurer, Girtanier, Jacquin the son, Avezula, etc.

As the contributions of each member of this brilliant coterie come to mind, their mere citation by Fourcroy means the highest praise for Lavoisier. And then he writes:

> I have taught this doctrine both in my public and private lectures for the last twelve years. If I flatter myself with having contributed in any degree to elucidate this system of modern chemical science either by lecture or writings, or by such discoveries as I have published within these years, I must be permitted to observe, that no other theory affords so true and full an explanation of the phenomena of nature and of the arts.

In due time the story of the revision of the old nomenclature is unfolded.

Fourcroy's chemistry surely proved an excellent guide to the students of the days when scientific chemistry began its career in America.

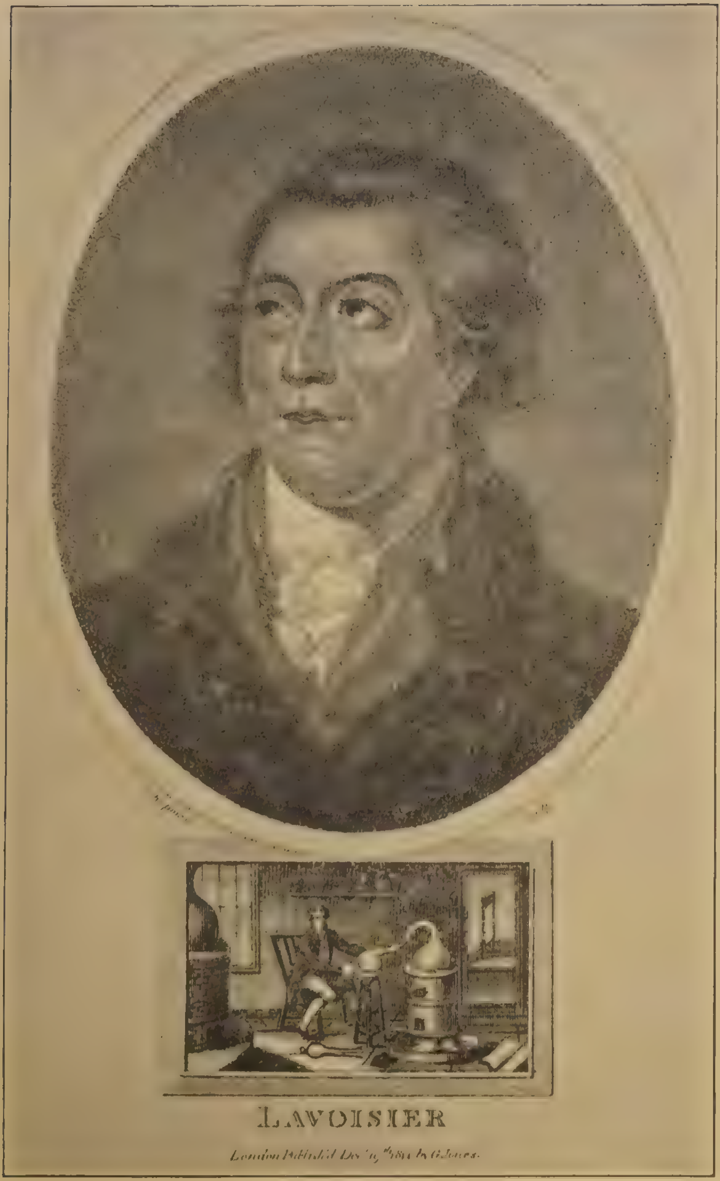
—Elements of Chemistry and Natural History, to which is prefixed The Philosophy of Chemistry, by A. F. Fourcroy. Translated from the fourth and last edition of the original French work, by R. Heron. 4 Volumes. London, 1796.

ANTOINE LAURENT LAVOISIER

There are interesting facts surrounding the publication of Lavoisier's Elements of Chemistry. Did not this immortal discoverer give a very new aspect to the science? Were not his observations and interpretations of old facts the dawn of a new day in chemistry? He had overthrown the doctrine of phlogiston; with his confreres—de Morveau, Berthollet, Fourcroy—had brought order out of chaos in the prevalent chemical nomenclature, and had demonstrated the law of the indestructibility of matter, etc. These were epoch-making achievements, and it is not difficult to understand the enthusiasm of Kerr of Edinburgh, who recorded that a copy of the "Elements" published first in 1789, having accidently fallen into his hands, so deeply impressed him that

> he was eager to give it to the public in English.

So favorable was the reception of this translation that two editions followed fast on the heels of the first, and having learned


LAVOISIER
London Published Dec 1st 1811 by G.Jones.

Antoine Laurent Lavoisier.

that a new French edition had appeared in 1792–1793, Kerr made haste to use it, but hearing promptly from Lavoisier that this edition "had been printed without his knowledge," it being entirely a transcript of the first edition, he set about making slight alterations with the sanction of Lavoisier, and let the book go out in that form,—the form in which it eventually reached American students. A reprint of the fourth edition was made in 1799 (Dec. 12) by Matthew Carey of Philadelphia. This edition is extremely rare. Attention was called to it not long since in the columns of SCIENCE,* and a photograph of the title page was at the same time given in the French Annals of Chemistry.

There seems not the slightest doubt but that Mitchill, Coxe, Woodhouse, Hare, Silliman and other early American chemists assiduously studied the pages of Lavoisier's Chemistry. Further, in 1806, an American edition from the fifth Edinburgh edition was issued in New York. It was a reprint, yet it showed the demand which was evidently made for the book.

Kerr also announced that—

> had Lavoisier lived, as expressed in a letter received from him by the Translator a short while before his massacre, it was his intention to have republished these Elements in an entirely new form, composing a complete System of Philosophical Chemistry. And, as a mark of his satisfaction with the fidelity of this translation, he proposed to have conveyed to the Translator, sheet by sheet as it should come from the press, that new and invaluable work, alas! now forever lost!

Originally it was not the purpose of Lavoisier to write a textbook on Chemistry; at least, a prefatory sentence reads:

> When I began the following work, my only object was to extend and explain more fully the Memoir which I had read at the public meeting of the Academy of Sciences in the month of April, 1787, etc.

Probably Lavoisier felt the impulse of all the new things upon him and hastened to give them to the chemical world. That same spirit expressed itself when electrolytic dissociation was heralded throughout the world in the late eighteen-eighties.

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* (Dec. 27, 1918), where a paragraph of the preface is quoted because of its bearing upon the scientific methods.

The work of Lavoisier is most refreshing reading. New view points were held aloft. But, confessedly, it surprises one to observe the great master in the very first chapter of his monumental treatise devoting great space to *caloric*, the

> exquisitely elastic fluid, which produces heat—this subtile matter (caloric) which penetrates through the pores of all known substances—since there are no vessels through which it cannot escape—and, consequently, as there are none which are capable of retaining it—we can only come at the knowledge of its properties by effects which are fleeting and difficultly ascertainable.

It would almost seem as if the great savant, having abandoned phlogiston and other fetishes, was searching for something of the same nature in other directions. However, the excellencies of his timely publication were so numerous and valuable that *caloric* may be passed. His remarks on air are highly illuminating, being accompanied by experimental demonstrations. But, why say more? This publication represented a definite advance in chemical science. It reached American shores in its English dress and continued for long the *vademecum* of students of chemistry—from the seventeen-nineties down through a period of fifty years. To not a few it became known and was studied in its French form. On glancing carelessly through its pages at this late date, many statements will arrest attention and cause the reader to forgetfully plough his way along through a great array of intensely interesting details, not wearying but impelling him onward. Who can determine the influence exerted by the *Elements* upon contemporary thought?

An anonymous American writer said:

> It is hardly possible to estimate too highly the influence which Lavoisier's work exerted on the history of chemistry. The first treatise on Chemistry in which the phlogistic theory was dropped and the new theory of combustion was clearly promulgated, in conjunction with the "Methode de nomenclature chimique," published two years before, it changed the existing language of chemistry and shaped the course of progress still pursued.

To the preceding paragraphs may be subjoined the following splendid letter from Lavoisier to Benjamin Franklin. The two copies of the book to which reference is made arrived in Philadelphia, but whether the great philosopher saw them cannot be determined. The letter of Lavoisier was written on February 2, 1790. It is not known whether the messenger left Paris immediately or not; nor is it known how much time was consumed in the passage. Franklin died April 17, 1790.

Sir and most illustrious colleague:

M. de Coullens de Caumont, who is returning to America, has been so good as to charge himself with two copies of a work which I published here about a year ago under the title of "Treatise on the Elements of Chemistry," one of which I beg you will accept with my best wishes, passing on the other to the "Society" in Philadelphia.

In all the works on chemistry which have been published since Stahl, the authors have begun by laying down an hypothesis and afterwards have attempted to show that with this given principle all the phenomena of chemistry might be accounted for tolerably well.

I believed, and a great number of scholars of today agreed with me, that the hypothesis advanced by Stahl, and since modified, is erroneous, that phlogiston in the sense that Stahl understood the word does not exist, and it was principally to develop my ideas on this subject that I undertook the work which I have the honor to send to you.

I have sought, as you will observe in the preface, to arrive at the truth by a coordination of facts; to suppress theorizing as much as possible, which is a treacherous instrument and has often led us astray, as has been demonstrated when opportunity has presented itself to test it in the light of observation and experiment.

This course, which has not hitherto been followed in chemistry, has given me an occasion to classify my work in an absolutely new way, and chemistry has been brought much closer than it was to experimental physics. I sincerely hope that your leisure and your health will permit you to read the first chapter, inasmuch as your support and that of those scholars of Europe who are without prejudice in matters of this sort is the object of my earnest ambition.

It seems to me that to present chemistry in this form is to render the study infinitely easier than it has been. Young men whose minds are not preoccupied with any other system seize it with avidity, but old chemists still reject it, and most of them have even more trouble in comprehending and understanding it than have those who have not yet made any study of chemistry.

The French scholars are divided at this moment between the old and the new doctrine. I have on my side M. de Morveau, M. Berthollet, M. de Fourcroy, M. de la Place, M. Monge, and in general the physicians of the Academy. The scholars of London and of England have unconsciously abandoned the doctrine of Stahl, but the German chemists adhere to it. This then is the revolution which has occurred in an important branch of human knowledge since your departure from Europe; I look upon this revolution as well advanced and it will be complete if you will stand with us.

Now that you have been informed as to what has transpired in chemistry, it might be well to speak of our political revolution. We look upon this as accomplished and accomplished irretrievably. There still exists, however, an aristocratic party, which makes futile efforts and whose weakness is very evident; the democratic party has on its side the greatest number and the most intelligent, able and enlightened. Conservative people, and those who have kept their heads in the general upheaval, think that events have swept us too far, that it is regrettable to have been obliged to arm the people and all the citizens, that it is impolitic to place authority in the hands of those who should be amenable to authority, and they fear that the establishment of a new constitution will only meet with opposition on the part of those who are in favor of what has been done.

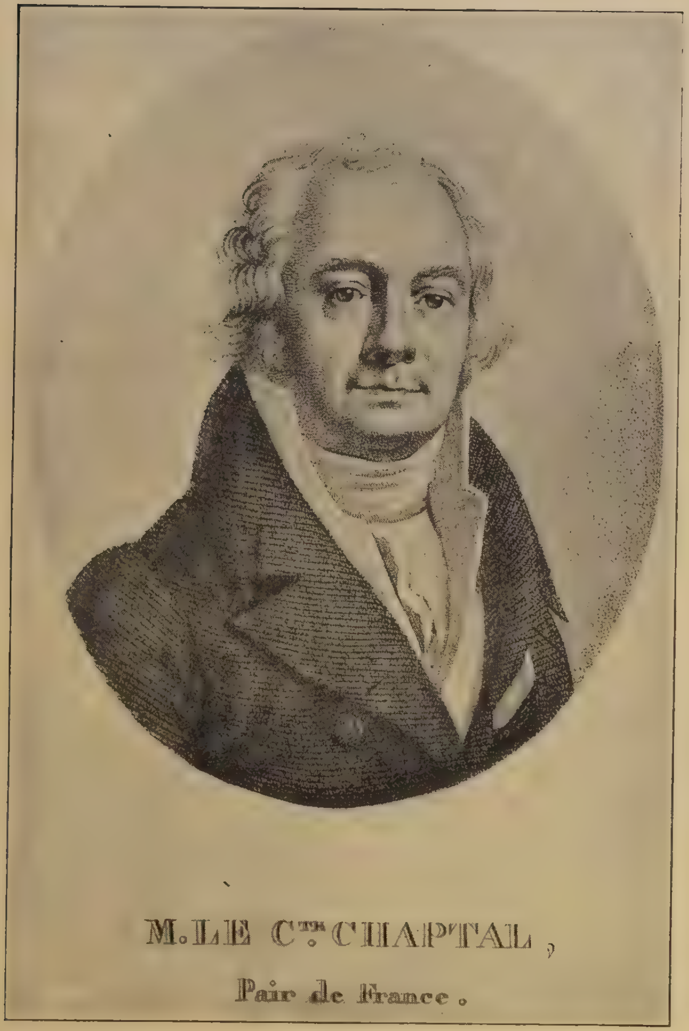
We have arrived at a most important epoch, as we are occupied at this moment, all over the realm, with the formation of municipalities, and it appears that the elections have been conducted in a very peaceable manner. The country has been divided into 83 departments or provinces, each department into districts, each district into cantonments, and the cantonments contain three or four municipalities; the public prints, no doubt, have advised you of all these details. We deeply regret, at this time, your absence from France; you would have been our guide and could have shown us the limits beyond which we ought not to pass.

I have the honour to be with inviolable affection and respect, Monsieur and very illustrious colleague, etc.

—Elements of Chemistry, in a new systematic order, containing all the modern discoveries, by M. Lavoisier. Translated from the French by Robert Kerr. Fourth Edition. Philadelphia: Printed for Matthew Carey, Decem. 12, M.DCC.XCIX.

M. I. A. CHAPTAL

Chaptal's Chemistry first appeared in France in 1790 in three volumes, and very promptly reached four editions in that country. It is extremely interesting in its subject matter. It is a descriptive chemistry, giving not only the facts that were



M. I. A. Chaptal.

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known at that period, but also aiming to apply chemistry to industry, the arts and agriculture.

This book and other writings of Chaptal quickly acquired an international acclaim, with the result that their author was invited by several European rulers to settle in their domains; and Americans should note

> that General Washington endeavoured to induce him to emigrate to this country, and three times sent him an invitation to that effect.

But, all these kind offers were declined, Chaptal preferring to serve his country. His zeal in this direction was very great. Napoleon not only made him Administrator of Public Instruction, but later Minister of the Interior. And, all the while he was engaged in the advancement of chemistry in France and the development of French industries

> promoting the useful arts and institutions, especially architecture and sanitary establishments.

He spent a large portion of his fortune in beet-sugar manufacture and in the promulgation of agricultural improvements. It is, therefore, not surprising that one whose vision in regard to the practical value of our science was so great, should have let his thoughts find expression in his text book, which was most favorably received throughout his native land. Quite early, it was translated into German, and into English a year after its appearance in France. The confidence in the value of the work is shown in these words of Nicholson, the English translator:

> the great experience of M. Chaptal, his unaffected candour and the perspicuity which is seen in every part of the treatise, cannot but render it extensively useful.

Three reprints of the English translation without any omissions or additions made their appearance in America. They bore the imprint of a Boston publishing house. The third American edition, in the hands of the writer at the moment, contains the three original volumes in one and appeared in the year 1806.

Woodhouse's edition, which is the fourth American edition, consists of two volumes, bearing the date 1807.

There are so many excellencies in Chaptal's Chemistry which might be called to the attention of students, that perhaps the wisest thing is simply to restrict comment to the statement that it is a work deserving of study at the present moment, especially by those who would appreciate an effort to give chemistry as wide application as possible. Woodhouse has freely annotated his edition, and from these "notes" one may gather a pretty correct idea of the material which that chemist presented 133 years ago to those who constituted his audiences. The writer, fortunately, possesses two volumes of Notes of Woodhouse's Lectures on Chemistry, as they were delivered from 1795 to 1809, and knowing their contents and familiar, also, with the material offered by Woodhouse's edition of Chaptal, it is easy to surmise that Woodhouse's students and his other audiences received the most recent communications and the most important efforts in the chemistry of the day.

In the *preliminary discourse* found in the opening pages of Chaptal occur these lines:

> The study of chemistry did not begin to be cultivated to advantage in France until the end of the last century. The first wars of Louis XIV, so proper to develop the talents of the artist, the historian, and the military man, appeared little favourable to the peaceable study of nature. The naturalist, who in his researches sees union and harmony around him, cannot be an indifferent spectator of the continual scenes of disorder and destruction; and his genius is crushed in the midst of troubles and agitations. The mind of the great Colbert, deeply penetrated with these truths, quickly endeavoured to temper the fire of discord, by turning the minds of men towards the only objects which could secure the peace and prosperity of the state. He exerted himself to render trade flourishing; he established manufactories; learned men were invited from all parts, encouraged, and united together, to promote his vast projects. Then it was that the ardour of inquiry replaced for a time the fury of conquest; and France very soon stood in competition with all nations for the rapid progress of the sciences, and the perfection of the arts. Lemery, Homberg, and Geoffroy arose nearly at the same time; and other nations were no longer entitled to reproach us for the lack of chemists. From that moment the existence of the arts appeared to be well

assured. All the sciences which afford their first principles, were cultivated with the greatest success; and it will scarcely be credited that, in the space of a few years, the arts were drawn from a state of non-entity; and carried to such a degree of perfection, that France, which had before received everything from foreign countries, became in possession of the glory of supplying its neighbours with models and with merchandise.

Chemistry and natural history, however, at the beginning of this century, were cultivated only by a very small number of persons; and it was then thought that the study of these sciences ought to be confined to the academies. But two men, whose names will be ever famous, have rendered the taste general under the reign of Louis XV. The one possessed that noble spirit which is a stranger to the power of prejudice, that indefatigable ardour which so easily overcomes every obstacle, that openness of character which inspires confidence, and transfused into the minds of his pupils that enthusiasm of which he himself felt the force. While Rouelle enlightened the science of chemistry, Buffon prepared a revolution still more astonishing in natural history.

Chaptal was a practical savant, treated with great regard by Napoleon, who constantly gave him proofs of appreciation of his talents.

The following anecdote, recounted by Chaptal himself, shows the circumspection necessary in approaching Napoleon . . . The celebrated Prussian scientist and traveller, Alexander von Humboldt, had settled in Paris in 1808, and the Emperor suspected him of being a spy.

One day he ordered Savary, Minister of Police, to have him removed from Paris within 24 hours. The order was communicated to Humboldt, who at once came to me (Chaptal) and asked me to speak to the Emperor on his behalf. I went to the Soiree at the Tuileries; as usual, the Emperor drew me aside to converse. "What is there new in the scientific world?" he asked. "Nothing," I answered, "and were not M. Humboldt publishing his travels in Central America, we should be in a state of complete stagnation." "These works are important, very important?" "They could not be more so. M. Humboldt is master of all the sciences, and when he travels, it is as if all the Academy of Science went too. It is astonishing that he has been able to collect in three years all the material on which he is working in Paris. Moreover he has adopted our Country; he publishes his work in our language, he employs our engravers, our artists, our printers." "Does he not also engage in politics?" "His reputation brings him in contact with many foreigners, who come to see him; but I have never known him concern himself with anything but science." "You think he is necessary to France?" "There would be general regret if he chanced to leave us." Napoleon called Savary, and ordered him not to put into execution the order which he had received that morning . . . and continued Chaptal, "if I had appeared to be aware of the step he had taken, and had spoken to him on the subject, I should have obtained nothing." —Mes Souvenirs sur Napoleon, published by Chaptal's grandson. Paris, 1893.

—Elements of Chemistry by M. I. A. Chaptal. 4th American edition, with great additions and improvements by James Woodhouse, M.D. 2 vols. Phila. 1807.

TORBERN BERGMANN

Would it be too severe a condemnation to declare that modern chemists have not, as a rule, learned to know Torbern Bergmann well? An enthusiastic admirer wrote, in the days when scientific chemistry was young, even in Europe:

> Among the many endowments of this great philosopher, none is more conspicuous than the anxious concern he everywhere discovers for the advancement of human happiness, and the earnestness with which he applies the great powers of his mind to such points as may be immediately applicable to the uses of life. He despises barren and unproductive speculation; he considers science as desirable only so far as it is beneficial; and proves himself on every occasion not only the Teacher but the Friend of mankind.

And the several publications of this man, in English dress, received the attention of the American Fathers in chemistry. What the influence of these publications may have been or the nature of the imprint imposed by their study is not now determinable. Bergmann adopted the lecture form of presenting his material. It consisted of dissertations or essays which appeared in the transactions of the Swedish learned societies. Thus, in *Physical and Chemical Essays* the first dissertation is upon the *aerial acid*, presented in 1774 before the Royal Academy of Sciences of Upsala. It is an instructive and entertaining story of carbon dioxide. Today we are so far away from 1774 that the impatience which enthrals us is apt to turn us at once from it. The writer, however, read the ninety pages of the descriptive

K. Mackenzie sc.
T. Bergman
Professor of Chemistry at Upsal
Published May 1st 1801.

Torbern Bergmann.

matter on the *aerial acid* with keenest interest. It was good to observe how in that distant period men set about unravelling the nature and studying the properties of the bodies surrounding them. Again, it was most worth while to examine critically the forms of apparatus employed in the demonstration work, and it may be added, that it pays to follow closely the development of chemical apparatus. The writer is quite sure that could four or five—a group, let us say,—of advanced chemical students,—sit down with *aerial acid*, reading and observing Bergmann's presentation, they would, at the conclusion, be enthusiastic themselves, and very probably be inclined to peruse "the Analysis of Waters" from which they would emerge with even greater admiration for Bergmann. This second inaugural essay, so far as its analytical side is concerned, is virginal in character. Those having a penchant for analysis will find it interesting and instructive, and of course, original in its thought, because as the text itself proclaims—

> As to the art of accurately examining waters, with regard to their contents, one scarce finds any traces of it worthy of observation, until the Seventeenth century.

And it is almost incomprehensible how any one, caring in the least for a knowledge of the evolution of chemical science, can find it in his heart to turn from these early stories. These beginnings are so basic!

Waters of every description are subjected in this thesis to exhaustive examination; for, the chemistry of water was then a burning question. And it may be here recorded that some of the first analytical work done in the seventeen-sixties in America was on spring waters.

Another dissertation (No. 9 in *Essays*) relates to *alum*. It is a minute and exhaustive examination of this substance; long before the isolation of aluminium and the nature of it were known. Little did Bergmann suspect in *alum* the presence of a metal that would dominate civilization to the degree which that metal has controlled it.

And so the dissertations proceed through the two volumes until an extremely complete course upon descriptive chemistry is laid before the student.

The third volume of *Essays* is devoted to the history of chemistry. This chapter has long been regarded as a classic. It is famous. References to it abound in later histories of the science. Bergmann properly considered the account of the development of the science, which was his mistress through life, as deserving the thought and attention of those who engaged in its pursuit.

The speculative ideas of Bergmann on affinity or attractions, not so many generations ago, were mentioned in the text-books devoted to theory. In more recent times, however, they are ignored, although it surprises one to observe how high they were held in early chemical text-books and how persistently elective attractions confronted the chemical student. To chemists of 1700 and early 1800 these views gave comfort if not absolute satisfaction. Their elucidation was a matter of moment, although little commotion or excitement was set astir by them. They may have been silly, meaningless—everything mentally despicable,—but, notwithstanding, they constituted a support and help in arriving at more excellent and advanced notions on chemical action, as well as on constitution. Bergmann's volume on chemical affinity should be read. In no other way can a true, correct idea of his aims be gained. The formulation of signs will delight the reader. Modern theorists find vent for strange graphic representation of the atom and all connected therewith. To such the tables arranged in Bergmann's texts will be encouraging, perhaps stimulating, yet they are all right as the benzene hexagon is all right. They serve to instil an idea.

If a course of reading in historical chemistry for advanced chemical students were inaugurated the volume just cited should by all means find place. It might not be necessary to study more than a few examples to gather the aims of this early exponent of the constitutional ideas of chemical bodies.

Chemical affinity—what it is—how measured, continues to engage earnest thought.

—Physical and Chemical Essays translated from the original Latin by Edmund Cullen, M.D. London, 1787.

Chemical Affinities or Elective Attractions, translated from the Latin —1788.

On the Usefulness of Chemistry and Its Applications to the Various Occasions of Life—1783.

M. MACQUER

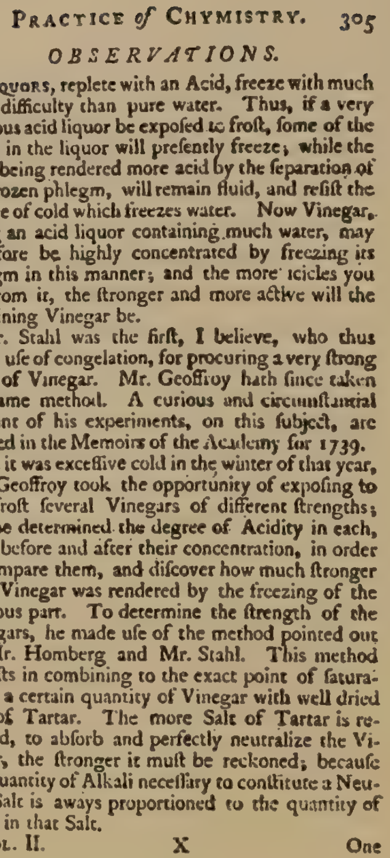
Elemens de Chymie Theorique (1749); Elemens de Chymie Pratique (1756), and a Dictionary (1766, 1778) by Macquer were, in their day, standard works. The second (Elemens de Chymie Pratique) is found in old American libraries; hence, undoubtedly had American readers both in its French form and in an English translation which appeared in London in 1764. Macquer's style is simple and at places quaint. All of his publications were most refreshing to the writer, whose only regret was that not more was known about this author (not so familiar as many other French writers on chemistry). Note what he wrote on *Kermes Mineral:*

Break any quantity you will of Hungarian Antimony into little bits; put it into a good earthen coffee-pot: pour on it twice its weight of rain water, and a fourth part of its weight of well filtered liquor of Nitre fixed by charcoal. Boil the whole briskly for two hours, and then filter the liquor. As it cools it will acquire a red colour, grow turbid, and leave a red powder on the filter.

Return your Antimony into the coffee-pot. Pour on it as much rain-water as before, and three fourths of the former quantity of the liquor of Fixed Nitre. Boil it again for two hours, and then filter the liquor. It will again deposit a red sediment. Return your antimony into the coffee-pot; pour on it the same quantity of rain-water, and half the first quantity of the liquor of Fixed Nitre. Boil it again for two hours, and filter the liquor as formerly. Wash all these sediments with warm water, till they become insipid; then dry them, and you have the *Kermes Mineral.*

OBSERVATIONS

If you recollect what we said concerning the property which Fixed Alkalies posssess of uniting with Sulphur, both by fusion, and, when those Salts



OBSERVATIONS.

LIQUORS, replete with an Acid, freeze with much more difficulty than pure water. Thus, if a very aqueous acid liquor be expoſed to froſt, ſome of the water in the liquor will preſently freeze; while the reſt, being rendered more acid by the ſeparation of the frozen phlegm, will remain fluid, and reſiſt the degree of cold which freezes water. Now Vinegar, being an acid liquor containing much water, may therefore be highly concentrated by freezing its phlegm in this manner; and the more icicles you get from it, the ſtronger and more active will the remaining Vinegar be.

Mr. Stahl was the firſt, I believe, who thus made uſe of congelation, for procuring a very ſtrong Acid of Vinegar. Mr. Geoffroy hath ſince taken the ſame method. A curious and circumſtantial account of his experiments, on this ſubject, are printed in the Memoirs of the Academy for 1739.

As it was exceſſive cold in the winter of that year, Mr. Geoffroy took the opportunity of expoſing to the froſt ſeveral Vinegars of different ſtrengths; and he determined the degree of Acidity in each, both before and after their concentration, in order to compare them, and diſcover how much ſtronger each Vinegar was rendered by the freezing of the aqueous part. To determine the ſtrength of the Vinegars, he made uſe of the method pointed out by Mr. Homberg and Mr. Stahl. This method conſiſts in combining to the exact point of ſaturation, a certain quantity of Vinegar with well dried Salt of Tartar. The more Salt of Tartar is required, to abſorb and perfectly neutralize the Vinegar, the ſtronger it muſt be reckoned; becauſe the quantity of Alkali neceſſary to conſtitute a Neutral Salt is aways proportioned to the quantity of Acid in that Salt.

Mathieu Joseph Bonaventure Orfila.

are resolved into a liquor, by boiling, and of forming therewith a Liver of Sulphur, which dissolves all metalline substances, you will readily comprehend the nature of this Kermes.

Antimony consists of a sulphurous and a reguline part. Therefore, if this mineral be boiled in a solution of a Fixed Alkali, such as Nitre fixed by Charcoal, the Alkali will dissolve the Sulphur of the Antimony, and form therewith a Liver of Sulphur; which in its turn will dissolve the reguline part. Now, Kermes Mineral, prepared as above directed is no other than a Liver of Sulphur combined with a certain quantity of Regulus of Antimony.

Mr. Geoffroy hath set this truth in the clearest light, by his accurate analysis of Kermes Mineral. The Experiments he made on that subject are circumstantially related in several Memoirs printed in the Volumes of the Academy for 1734 and 1735.

And, in such manner, Macquer presents his various subjects to the reader. What dreams do come when meditating on the contents of such early efforts in chemistry! Do many readers of these lines know Macquer or Geoffroy?

MATHIEU JOSEPH BONAVENTURE ORFILA

The text of Orfila had an influence upon the earlier generations of American chemists. It was translated and published in 1818 by Dr. John Redman Coxe in Philadelphia. The translator believed and declared

> that few works can be found, in which so much matter of practical tendency is embodied in so small a compass.

The section on Analysis, borrowed to some extent from the work of Thenard, reads well and must have been welcomed by chemists desirous of perfecting themselves in this branch of chemistry. Toxicological sections are numerous and quite complete. This is in no wise surprising as Orfila made toxicology a subject of special study and investigation. Marls, limestones and objects of value to the agriculturist receive consideration.

Of particular historical interest is the insertion of a letter of Berzelius to Alexander Marcet, published in 1818 in Thomson's *Annals of Philosophy*, relating to the discovery of lithium and selenium. This communication is one of those gossipy accounts of two new members of the chemical family. It is of the class that one only now and then gets from such a Solon as Berzelius was. It adds a decided element of personality or humanness to a profound subject.

Some early owner of the copy of Orfila's chemistry, lying before the writer, was moved to paste a bit of writing paper on the outer cover of the book and to inscribe on the paper in very black ink—

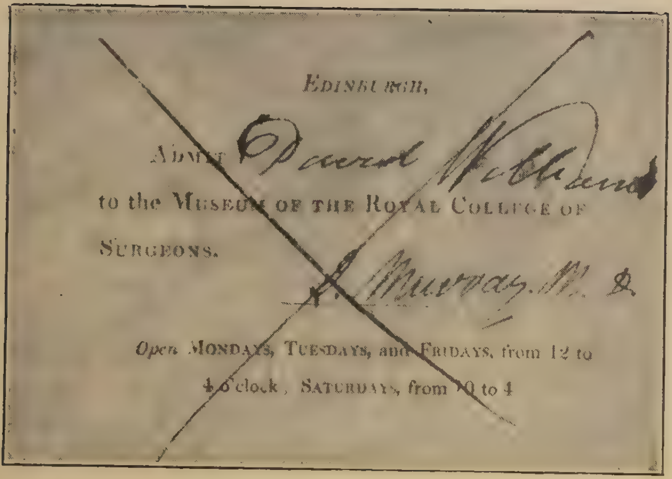
PRACTICAL CHEMISTRY
By Coxe
A first rate book

The writer also would say,—"a first rate book;" for so it has impressed him in its perusal.

—**Traite de Toxicologie General, 1813–1815. Lecons de Médicine legale, 1823.**

JOHN MURRAY

Not every English text-book on Chemistry, laid before American chemists, was enthusiastically received. Of this class was Murray's four-volumed production, which, on careful examination and study exhibits many praiseworthy features, notably the exceedingly complete and lucid presentation of chemical attraction or affinity and caloric. These are topics which, in the earlier days of the science, engaged the thought of all chemists. Indeed, they rivalled, in the attention they received, the phlogiston hypothesis, and outlived it, appearing in texts as late as the eighteen fifties. Today one would approach this subject with hesitancy, yet in seeking to follow chemical development through its upward course and ramifications one needs to acquaint himself with the several stages. In studying affinity and caloric the text of Murray will prove a great aid. These subjects are brilliantly set forth by the author. In fact, the entire work displays decided merit. The edition of 1812



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which the writer studied was the third edition, indicating that at least in the home-land it had had an appreciative constituency. Stray copies of the book slowly found their way to America—but it did not become well known.

Murray, according to Silliman the elder, was a private lecturer on chemistry, a young man much distinguished for a clear philosophical mind, and a happy flow of luminous language. While John Griscom in his "A Year in Europe" mentions having on several occasions heard Murray lecture and remarked that—

> this eminent chemist has been for several years in such bad health, as seldom to venture out of doors. He passes by a covered way, from his chamber to his lecture room and spends no more time in his laboratory, than is absolutely unavoidable. His lectures and publications have contributed very considerably to the scientific eminence of Edinboro. Notwithstanding the popularity of the collegiate course of chemistry, he has always been attended by a respectable class; and few men, who have ever filled a chemical chair, have exceeded him in the perspicuity of his views, and the acuteness with which he examines the prevailing theories of the science.

—A System of Chemistry by John Murray, F.R.S.E. Lecturer on Chemistry and on Materia Medica and Pharmacy. Edinburg. 1812.

WILLIAM HENRY

Chemists of the present do not realize the influence exerted on Americans by the text-book of William Henry, M.D. which made its appearance in London shortly after the beginning of eighteen hundred, where it was most kindly received. It bore at first the title of "Epitome of Chemistry," originally compiled in the words of the author

> at a period, when we had not, in the English language, any elementary book on this science, of similar plan and intentions, and before I had seen the only work which is at all coincident in design with my own, the *Manuel d'un Cours de Chimie, par Bouillon la Grange.*

It was in 1808 that American editions of the English work appeared, due mainly to the influence of Silliman the Elder, who with Maclean of Princeton, said

> in consequence of the favourable opinion we entertain of the *Epitome* we have adopted it as a text-book for our respective classes.

And, on the title page occur these words:

> From the Fourth English Edition
> To which are added *Notes* by a
> Professor of Chemistry in this
> Country.

The American professor was, of course, B. Silliman, the elder.

And, Stringham, Professor of Chemistry in Columbia, said:

> I consider it by far the best work (of its size) that has appeared on the subject. The style is classical, the most approved doctrines are adopted, the experiments are detailed with precision and the whole exhibits a beautiful illustration of the facts on which Chemical Science is founded.

Again, in 1810, Silliman issued the second American edition to which are added:

> Notes on various subjects; Observations of Metals; Mines; Mining; Metallurgy; and on the Artificial Preparation of Mineral Waters; an Account of the New Discoveries of Professor Davy, and of the French chemists; and of Meteoric Stones &c.—with a Frontispiece, exhibiting the Pneumatic Cistern of Yale College.

The work was arranged in three parts:

> 1st Part—Intended to facilitate the acquisition of Chemical Knowledge, by minute instructions, for the performance of experiments.
>
> 2nd Part—Directions for the analysis of Mineral Waters; of Earths and Stones; of Metallic Ores; and of mineral bodies in general.
>
> 3rd Part—Instructions for applying chemical tests and reagents to various Useful Purposes.

Revision after revision of the subject matter of the book took place in England until in 1818, it appeared as

> Elements
> of
> Experimental Chemistry

William Henry.

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and was dedicated

To
John Dalton
as
A Testimony of Respect
for the
Zeal, Disinterestedness and Success
with which
he has devoted himself to
advancement of Chemical Philosophy,
this work is inscribed
by his friend—the Author.

The following year (1819) Robert Hare ventured before the public with an annotated American Reprint. This was soon after he assumed the chair of chemistry in the University of Pennsylvania (1818).

In his day Henry was a modern and his treatise was indeed attractive and stimulating. He enthused on the nature and objects of chemistry, as well as on its connection with the arts and other sciences, as plainly indicated in the following words:

> It unfolds the most sublime views of the beauty and harmony of the Universe; and develops a plan of vast extent, and uninterrupted order, which could have been conceived only by perfect wisdom, and executed by unbounded power. By withdrawing the mind, also, from pursuits and amusements that excite the imagination, its investigations may tend, in common with the rest of the physical sciences, to the improvement of our intellectual and moral habits; to straighten the faculty of patient and accurate thinking, &c. &c. . . . Then, there is its capacity of ministering to our wants and our luxuries, and of instructing us to convert to the ordinary purposes of life, many substances which nature presents in a rude and useless form.

The introduction to the book was a fervid appeal and presentation of chemistry's usefulness "thro the union of theory with practice." The descriptive portion is excellent. It attracted many readers even those who were but moderately interested in chemistry.

Before the writer lie the two volumes constituting the 11th edition of the *Elements* of the year 1829. It was said on the title page that they "comprehended all the recent discoveries" in the science. Whether they did or not they were delightful reading. One might say "fascinating reading," but very probably matter-of-fact chemists would smile at the thought of any chemical reading being "fascinating," but to them be it said that it surely is so! The preface itself is delightful. So that must be the writer's excuse for giving the following abstracts— they contain so much of the human, vitalizing element!

> It is impossible to direct our views to the future improvement of this wide field of science, without deeply lamenting the privation, which we have lately sustained of two of its most successful cultivators, Sir Humphry Davy and Dr. Wollaston . . . with excellencies common to both they were nevertheless distinguished by marked intellectual peculiarities. Bold, ardent, and enthusiastic, Davy soared to greater heights; he commanded a wider horizon, and his keen vision penetrated to its utmost boundaries. His imagination, in the highest degree fertile and inventive, took a rapid and extensive range in pursuit of conjectural analogies, which he submitted to close and patient comparison with known facts, and tried by an appeal to ingenious and conclusive experiments. He was imbued with the spirit, and was a master in the practice of the inductive logic; and he has left us some of the noblest examples of the efficacy of that great instrument of human reason in the discovery of truth. He applied it, not only to connect classes of facts of more limited extent, and importance, but to develop great and comprehensive laws, which embrace phenomena that are almost universal to the natural world. In explaining those laws, he cast upon them the illumination of his own clear and vivid conceptions;—he felt an intense admiration of the beauty, order, and harmony, which are conspicuous in the perfect *Chemistry of Nature;*—and he expressed those feelings with a force of eloquence, which could issue only from a mind of the highest powers, and of the finest sensibilities. With much less enthusiasm from temperament, Dr. Wollaston was endowed with bodily senses of extraordinary acuteness and accuracy, and with great general vigor of understanding. Trained in the discipline of the exact sciences, he had acquired a powerful command over his attention, and had habituated himself to the most rigid correctness, both of thought and of language. He was sufficiently provided with the resources of the mathematics, to be enabled to pursue, with success, profound enquiries in mechanical and optical philosophy, the results of which enabled him to unfold the causes of phenomena, not before understood, and to enrich the arts, connected with those sciences, by the invention of ingenious and valuable instruments. In *Chemistry* he was distinguished by the extreme

nicety and delicacy of his observations; by the quickness and precision, with which he marked resemblances and discriminated differences, the sagacity, with which he devised experiments, and anticipated their results; and the skill with which he executed the analysis of fragments of new substances, often so minute as to be scarcely perceptible by ordinary eyes. He was remarkable, too, for the caution, with which he advanced from facts to general conclusions; a caution which, if it sometimes prevented him from reaching at once to the most sublime truths, yet rendered every step of his ascent a secure station, from which it was easy to rise to higher and more enlarged inductions. Thus these illustrious men, though differing essentially in their natural powers and acquired habits, and moving, independently of each other, in different paths, contributed to accomplish the same great ends —the evolving new elements; the combining matter into new forms; the increase of human happiness by improvement of the arts of civilized life; and the establishment of general laws, that will serve to guide other philosophers onwards, through vast and unexplored regions of scientific discovery.

Has any fairly recent text in chemistry so eulogized modern distinguished workers in the science?

—The Elements of Experimental Chemistry, by William Henry, M.D. F.R.S. Eleventh Edition. 2 volumes. London, 1829.

JAMES CUTBUSH

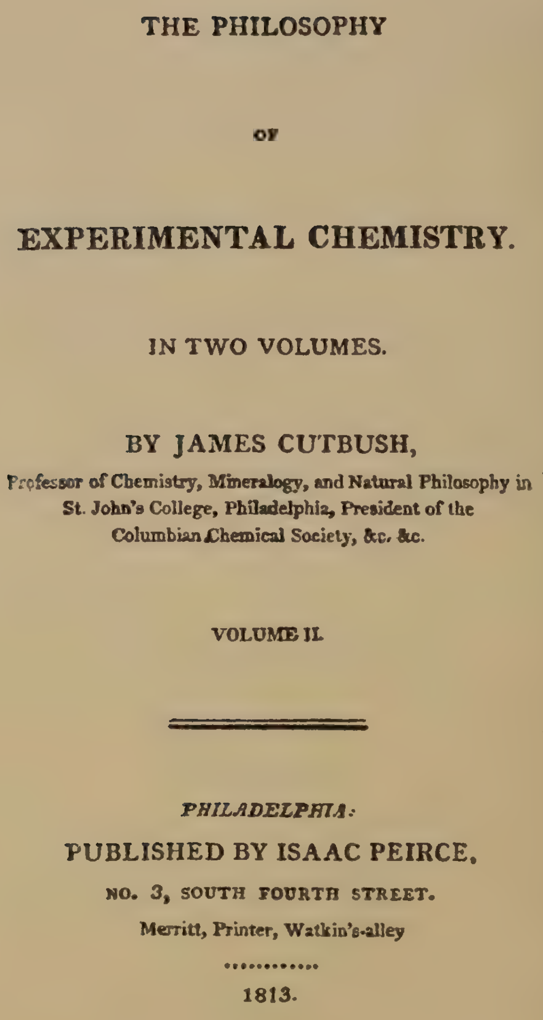
One of the earliest text-books on chemistry prepared by an American and published in America was "The Philosophy of Experimental Chemistry" in two volumes, in the year eighteen hundred and thirteen, Philadelphia.

Its aim was to present the facts of chemistry "in experiment, rationale and remark." Thus

Exper. 8. Place a pan of *snow* over a fire, and immerse a thermometer in it; notwithstanding the accession of heat, during the process of melting, the temperature will be found to be the same. When the *whole* becomes fluid, the temperature will *then* be raised.

Rationale—This is a case, in which caloric chemically combines with the snow; hence the thermometer is not raised; but when the whole is melted, the accession of heat is then shewn by the rise of the mercury, because the caloric which enters becomes sensible or free heat.

Remark—As ice has the property of absorbing all the caloric with which it comes in contact, and from the preceding experiments, communicates



THE PHILOSOPHY

OF

EXPERIMENTAL CHEMISTRY.

IN TWO VOLUMES.

BY JAMES CUTBUSH,
Professor of Chemistry, Mineralogy, and Natural Philosophy in
St. John's College, Philadelphia, President of the
Columbian Chemical Society, &c. &c.

VOLUME II.

PHILADELPHIA:
PUBLISHED BY ISAAC PEIRCE,
NO. 3, SOUTH FOURTH STREET.
Merritt, Printer, Watkin's-alley
....
1813.

no part of it to the surrounding bodies till the whole is melted; it therefore has been employed as the means by which the specific *caloric* of substances may be calculated. The instrument for this purpose is called a calorimeter.

In these paragraphs is exhibited the scheme of Cutbush in presenting his science. It prevails throughout the entire work and further examples may well be thought superfluous, but another will be offered as it contains a bit of chemical history not wholly devoid of interest to American chemists:

> Exper. 33. Procure a piece of *potash*, made perfectly pure, breathe on it, in order to moisten it, and place it on an insulated plate connected with the negative side of a powerful galvanic battery. Then bring a metallic wire from the positive side of the battery in contact with the upper surface of the alkali, and a vivid action will soon be observed. Small globules of the appearance of mercury will be seen, some of which will burn with an explosion and bright flame as soon as they are formed. These are *potassium.*
>
> Rationale—The potash is decomposed; oxygen gas is separated at the extremity of the positive wire, and *potassium* is formed at the other.
>
> Like other combustible substances, the combustible base is repelled by positively electrified surfaces, and attracted by negatively electrified surfaces; and the oxygen follows the contrary order. Hence their separation and evolution.
>
> Remark—Heretofore various opinions have been entertained respecting the composition of potash, in which the chemists of Europe were engaged in order to ascertain the correctness of these conjectures. But the researches of Sir Humphrey Davy have shown, that potash is a compound body, having a peculiar metal for its basis, to which he has given the name of potassium, united with oxygen. It has been supposed, ever since our countryman, Dr. Woodhouse, made an experiment with potash, that this alkali had an inflammable basis. I am disposed to believe that the Doctor was the first who hazarded this conjecture as to the inflammable nature of potash *when treated in certain ways.* The Doctor found that a mixture of pearl ash with soot, calcined by a very intense heat in a covered crucible, caught fire on the affusion of water; the experiment was repeated with the same result; and the inflammation probably arose from the action of the base of the alkali on the water.

Dr. Woodhouse did on other occasions find the evidences of his having separated the basis (potassium) from the caustic alkali (KOH) by his own original method, although there is no published record of this observation. Thomas Cooper, in his writings, claimed for Woodhouse this interesting discovery.

The volume of Cutbush shows the splendid growth of chemistry in America, and exhibits the zeal with which the science was propagated.

—The Philosophy of Experimental Chemistry by James Cutbush. Professor of Chemistry, Mineralogy, and Natural Philosophy in St. John's College, Phiadelphia, President of the Columbian Chemical Society, &c., &c. Phila. Published by Isaac Peirce, No. 3, South Fourth Street, 1813.

THOMAS EWELL

In the year 1806 "Plain Discourses on the Laws and properties of Matter: containing the elements or *principles* of *Modern Chemistry*, &c." was published by one of the Surgeons of the United States Navy. It was addressed to "all American Promoters of Useful Knowledge," and inscribed to Thomas Jefferson, of Virginia, then President of the United States of America, and in the dedication occur these words:

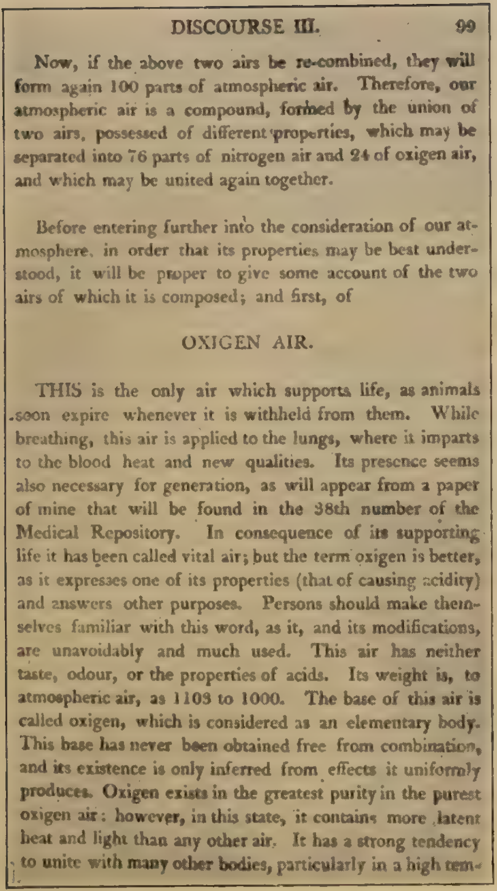
> In preparing the following plain discourses I was stimulated
> by a desire to emulate you in doing good.

It is a refreshing bit of chemical literature; for, witness this:

> The following plain work I prepared with a view to lessen the difficulties, and to increase the conveniences of the citizens of the United States, by introducing them to a more intimate acquaintance with chemistry.

One wonders how old the desire is to have men really know our science! Efforts to achieve this goal persist even today. The author, Thomas Ewell, M.D. of Virginia, was certainly wide-awake in his scheme, to bring chemistry right home to every man. From Thomas Jefferson he received this letter:

> Monticello, Aug. 1805.
>
> Of the importance of turning a knowledge of chemistry to household purposes, I have been long satisfied. The common herd of philosophers seem to write only for one another. The chemists have filled volumes on the composition of a thousand substances of no sort of importance to the purposes of life; while the arts of making bread, butter, cheese, vinegar, soap, beer, cider, &c remain unexplained. Chaptal has lately given the chemistry of wine making; the late Dr. Penington did the same as to bread,



DISCOURSE III. 99

Now, if the above two airs be re-combined, they will form again 100 parts of atmospheric air. Therefore, our atmospheric air is a compound, formed by the union of two airs, possessed of different properties, which may be separated into 76 parts of nitrogen air and 24 of oxigen air, and which may be united again together.

Before entering further into the consideration of our atmosphere, in order that its properties may be best understood, it will be proper to give some account of the two airs of which it is composed; and first, of

OXIGEN AIR.

THIS is the only air which supports life, as animals soon expire whenever it is withheld from them. While breathing, this air is applied to the lungs, where it imparts to the blood heat and new qualities. Its presence seems also necessary for generation, as will appear from a paper of mine that will be found in the 38th number of the Medical Repository. In consequence of its supporting life it has been called vital air; but the term oxigen is better, as it expresses one of its properties (that of causing acidity) and answers other purposes. Persons should make themselves familiar with this word, as it, and its modifications, are unavoidably and much used. This air has neither taste, odour, or the properties of acids. Its weight is, to atmospheric air, as 1103 to 1000. The base of this air is called oxigen, which is considered as an elementary body. This base has never been obtained free from combination, and its existence is only inferred from effects it uniformly produces. Oxigen exists in the greatest purity in the purest oxigen air: however, in this state, it contains more latent heat and light than any other air. It has a strong tendency to unite with many other bodies, particularly in a high tem-

Page from Ewell's Modern Chemistry.

Face p. 60

> and promised to pursue the line of rendering his knowledge useful to common life; but death deprived us of his labours. Good treatises on these subjects should receive general approbation.
>
> Th. Jefferson

And, in practically the same vein, wrote Bushrod Washington —Judge Washington—the beloved Mecaenas of Mount Vernon.

The work of Dr. Ewell is popular in its presentation of chemical facts and was read by many with approving interest. It became a favorite.

In speaking of the rescue of chemistry "from a state of darkness and contempt" Ewell observed that it was due to the reasonable expectations of man, who embraced it as a real science. He continues:

> Some of our infant country have aided in the glorious reformation and establishment . . . The celebrated Dr. Mitchill of the U. S. Senate made some ingenious suggestions . . . The accurate experimenter, Prof. Woodhouse of Philadelphia, and the learned Dr. Maclean of Princeton College are among the foremost on the list of chemists in this country. It is from the interesting lectures of these respectable characters, that many of the rising generation have received a love for chemistry.

In the introductory address, the book consisting actually of 15 discourses or addresses—occur the following choice quotations:

> No individual can now do too much in promoting the study of chemistry. The call for immediate advancement throughout the Republic is great. Ye free agents! Ye Guardians of the young! Can you allow those under your care to neglect learning the principles of this all-important science? What then will you say, when arraigned at the bar of justice, before a Creator and an assembled Universe, for neglect of your duty! Your hoary locks will not cover you! The number of the accused will naught extenuate—and in vain will you deny the charge! The children of successive generations will rise up around you! In the face of heaven they will bitterly complain of the beauties to which they were insensible! While humanity, bewailing her misfortune, will recount the number of blows she received, and the number of denials made to her call, because these creatures could not perceive the pleasures of her paths!
>
> Fellow citizens, I really feel incapable of properly stating the beauty, the connexion, and the importance of the science of Chemistry. For you to

know these you must know the science itself. This understood, your souls would feast on the eternal beauties of nature, while you were inhaling the grateful incense arising from your services to the cause of humanity.

The final discourses are very entertaining and instructive. They are bright and breathe out great enthusiasm. The book does not contain a chemical symbol, and equations are conspicuous by their absence.

—Plain Discourses on the Laws or Properties of Matter: Containing the Elements or Principles of *Modern Chemistry;* with more particular details of those practical parts of the Science most interesting to Mankind and connected with domestic affairs. Addressed to all American promoters of useful Knowledge by Thomas Ewell, M.D. of Virginia, one of the Surgeons of the United States Navy. New York—1806.

SAMUEL PARKES

It is probable that the mere mention of "Chymical Catechism" will cause students of chemistry to turn from engagements of the moment to make inquiry. They might ask, "What is the Chymical Catechism?" It was a delightful elementary chemistry, written by Samuel Parkes, who styled himself a "manufacturing chymist."

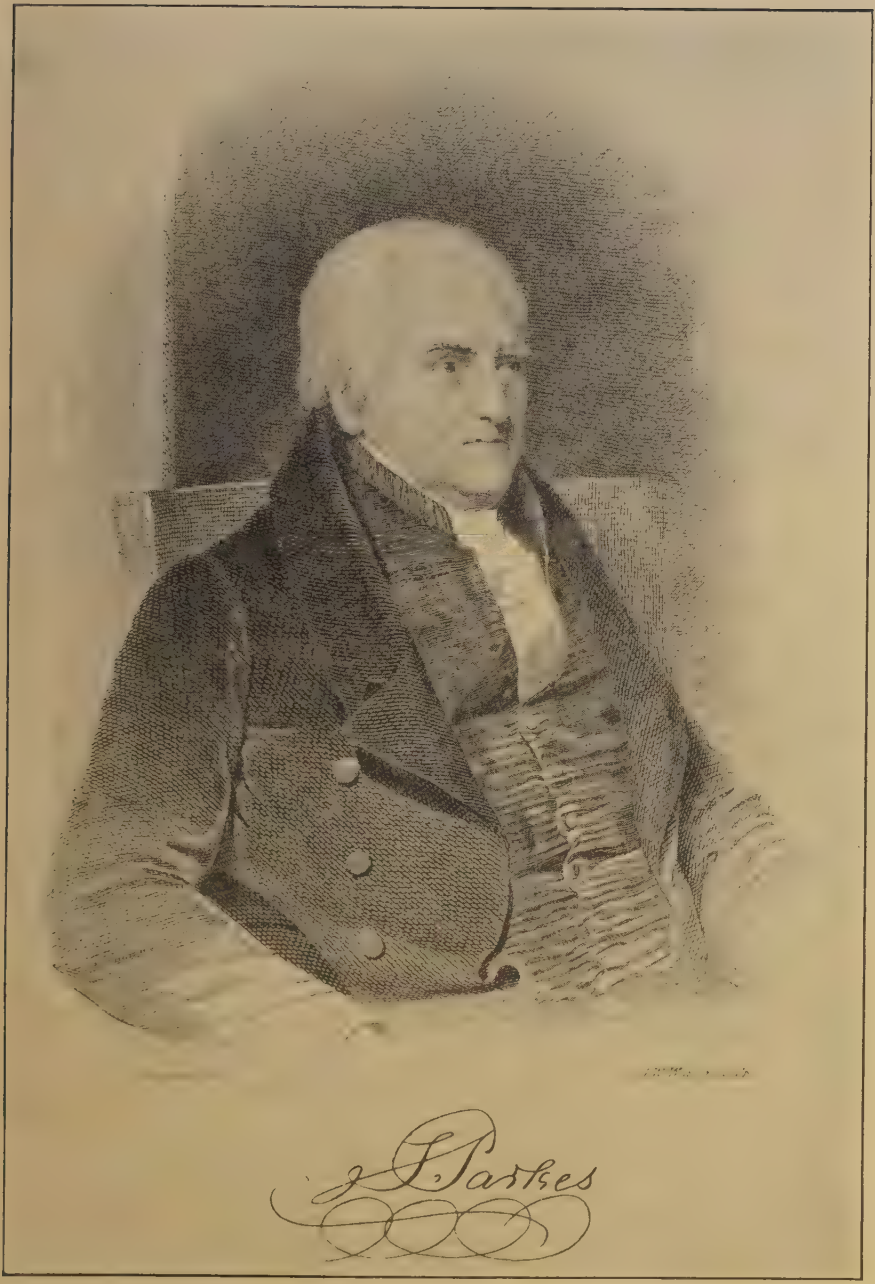
The first edition of the book appeared in 1806 and numbered 1500 copies, the smallest edition of the book that was ever printed. The second edition appeared in 1807. So great was the demand for this interesting introduction to chemistry that during a period of eighteen years, eleven editions appeared.

The first American edition came from the press of James Humphreys in Philadelphia in the year 1807.

> It was embellished with a frontispiece of the economical laboratory of Dr. James Woodhouse.

In other parts of the United States reprints of the book appeared. One English writer remarked

> that probably no author ever attracted so many students to the science on which he was treating as Mr. Parkes did to the study of chymistry by the publication of his "Catechism." The easy familiarity of its style, the happy knack which he possessed of rendering the driest and otherwise most unattractive parts inviting and pleasing, by interspersing them with useful and



S. Parkes

Samuel Parkes.

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> interesting matter not immediately connected with his subject, added to the admirable system of arrangement, adapted to lead imperceptibily from the rudiments to the higher branches of the science, all conduced to allure the reader to pursue with ardour so fascinating a research.

The twelfth edition of the book was the last prepared for the press by its author. Other editions followed, so that for almost half a Century the "Chymical Catechism" was a decided favorite among students.

This book had its origin in a desire on the part of Samuel Parkes

> to make his only child a proficient in his favourite pursuit, and unable to find an elementary work calculated to teach the rudiments of the science, he began to compile, with great assiduity and care, what he thought better adapted for a young person than any treatise which he had seen.

It was not his intention to publish his manuscript, but a friend

> wishing to instruct his children in chemistry, and not approving of any work which he had been able to procure, applied to Mr. Parkes for advice. The latter lent him the manuscript which he had written for his boy. The inquirer, pleased with the perusal, and confident that it was exactly the book that had so long been required, became urgent in his importunities with Mr. Parkes to publish it.

Parkes never dreamed of its wide use throughout the United States, Germany, France, Spain and Russia.

Believing that something even more elementary than the "Catechism" was required for the schools, Parkes wrote "The Rudiments of Chemistry." This appeared in 1809, and ran through a number of editions in England, as well as reprints in New York, and Philadelphia. He was also the author of "Chemical Essays" which he regarded as his principal work. The "Essays" were written in furtherance of the great object of which Parkes never lost sight, namely, the application of chemical science to the arts and manufactures of his native land. They appeared in several editions as well as in translations. Whoever sees fit to examine these three works by Samuel Parkes will be filled unconsciously with a desire to know their genial author. One can scarcely imagine that early in the Nineteenth Century such large editions of the "Catechism" should have been called for. The merits of the book seemed to grow as the years went by, and it is said that the "Catechism" was identified with his very name and bore all the characteristics of his powerful and original mind. It was the work to which its author was the most fondly devoted: it was his first production; it was the foundation on which his reputation as a chemist had been raised. The Government of Spain ordered the "Catechism" to be used in all its schools and colleges and the autocrat of all the Russias presented its author with a splendid and valuable ring.

By questions and answers Parkes succeeded in setting forth the principles and the important facts of the science to those desiring it. His method of approach may be looked upon as antiquated; yet, in these days when the question of how chemistry should be taught is so widely discussed, one wonders whether the oldest schemes might not be restudied with profit.

And in a prefatory paragraph, Parkes said:

> The work would be very incomplete should the author neglect to offer the student some of those moral reflections, which spontaneously arise in every contemplative mind, when considering the magnificent system of nature: and though such remarks may perhaps be regarded by some as irrelevant to chemical science, yet . . . it may be observed that, in compiling any initiatory book, no writer, as a parent, could lose sight of the necessity of embracing every favourable opportunity of infusing such principles into the youthful mind, as might defend it against immorality, irreligion, and scepticism.

In experiments Parkes was delicate and sure, never disheartened by failure, or by the tediousness of the operations, and rarely stated any fact in his books till he had previously verified it himself.

In the *Museum of Foreign Literature and Science*, Vol. II (1827), p. 180, may be found a most interesting life-sketch of Samuel Parkes.

—A Chymical Catechism: or the Application of Chymistry to the Arts &c. By S. Parkes, Manufacturing Chymist. Philadelphia 1807.

LONDON, Published for the European Magazine by J. Asp [illegible] Cornhil.
Fredrick Accum Esq.re

Fredrick Accum.

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FREDRICK ACCUM

There is abundant evidence that *Accum's Chemistry* in its Americanized form proved a decided help to chemical students of the early years of the 19th Century. References to it in the writings of American chemists show this, as do letters of that period.

Cooper, who revised it, did not venture to alter the text, but contented himself with notes, remarking that

> upon the whole, it seems to me that Accum's method of treating the subject of chemistry, is more satisfactory to students than any other of the elementary treatises that have appeared.

He was complimentary in his references to the texts of Murray, Thomson and Henry but preferred Accum. At this period he had aroused great interest in chemistry among the students of Dickinson College.

Under *Chemical Affinity* he wrote:

> Observation has shown that affinity of composition offers certain invariable phenomena which being founded on a great number of facts, are regarded by chemists as laws, and may be reduced under the following heads.

There are eight different heads but they need not be enumerated. They are accompanied by proofs and experiments. In this mode of treatment the text differs widely from other texts of the same period.

It is difficult to resist the desire to show his mode of treatment, so the sixth law may be introduced. It reads:

> *The ratio of the energy of chemical affinity acting between various bodies is different in different substances.*

Now, hear his reasoning:

> This is the most important law of chemical attraction. As beginners will find it rather difficult to understand what passes in this more complicated agency, we shall shortly remark, that the combination which is effected between two or more bodies, by virtue of the affinity of composition, becomes broken whenever we present to the compound another body which has an attraction to one of the constituent parts of the compound, superior to that

attraction by which they were held together: the bodies, therefore, between which the strongest attraction prevails combine, and the rest are disengaged.

Next came the experiments in proof of the law. For example, Accum said:

> If muriatic acid be poured either on pure barytes or on its carbonate, the barytes will be dissolved, and the compound will be muriate of barytes, which compound is held together by the force of affinity existing between the muriatic acid and the barytes. On letting fall into this solution a few drops of sulphuric acid, an immediate change of principles takes place; the whole quantity of the muriatic which was combined with the barytes becomes disengaged, and the sulphuric acid unites to the barytes with a force equal to their affinity, *minus* that of the muriatic acid.

In another experiment Accum wrote

> If pure silver be dissolved in nitric acid, the silver will remain united to the acid till another body is presented to it which has a greater force of attraction to one of the constituent parts of the compound: for instance, if mercury be added to the solution of silver, the mercury will be dissolved, and the silver become precipitated or disengaged. The supernatant fluid will then be a *solution of mercury in nitric acid.*

And, again—

> If to the before-mentioned solution of mercury in nitric acid a piece of sheet lead be presented, the lead will be dissolved, and the mercury become precipitated. The fluid will then be a *solution of lead in nitric acid.*

While—

> If in this solution of lead a thin slice of copper be suspended, the copper will be dissolved, the lead will be disengaged. The fluid now is a *solution of copper in nitric acid.*

He next introduces a sheet of iron and the copper is precipitated, and later zinc is brought into the resultant iron solution, whereupon the iron is precipitated.

Finally, Accum remarks:

> It appears nevertheless, from Berthollet's Treatise . . . that in almost all cases of elective affinity, there is not a total transfer of the base, but that a division is made between the two opposite attracting substances, in a compound ratio of the relative force of affinity and quantity of each; that in

Thomas Thomson.

many cases, the excess of quantity may supply the deficiency of force, and therefore that the *mass* must be carefully taken into consideration.

The experiments on *caloric* or heat are similarly set forth. Throughout the text the experiments are profuse. Their design was to have the student himself make the proofs of textual statements. In the present day or in days not so far behind us, laboratory work in connection with the texts was greatly emphasized; yet a Century ago, there were just such plans in vogue. The laboratory method, therefore, is far from being of recent date.

Slowly reading the observations on the metals there is met on p. 126 (2nd volume) an account of *Nickolinium.* Dr. J. B. Richter is credited with having announced this metal. He said

> that he was chiefly surprised that *nickel,* after being purified from cobalt, iron and arsenic . . . was always found dispersed in small particles in a hard, heavy mass, having no metallic lustre, neither was it attracted by the magnet.

There followed a lengthy account of how further the stranger differed from real nickel. The entire story recalls and reminds one of gnomium which Gerhardt Krüss believed he had separated from nickel.

A reviewer of Accum's book would call it a good book. Its points of excellence are many.

—System of Theoretical and Practical Chemistry. By Frederick Accum, 2 vols. Second American Edition, by Thomas Cooper, Professor of Chemistry in Dickinson College, Carlisle, Pa. Philadelphia. Published by Kimber and Conrad, 1814.

THOMAS THOMSON

When the life story of Dr. Thomas Cooper shall be written, his ardent interest in chemistry in its earliest years in America will manifest itself. He cared much for its literature and was active in the dissemination of the best of England, and in his own personal contributions aimed to present the facts and theories of the science in such ways as to be most helpful to students and beginners of chemistry.

From Dickinson College, Carlisle, Pa., he came to the Chair of Chemistry in the department of Arts and Sciences in the University of Pennsylvania, and while ocupying this post he presented to the public his revision of *Thomas Thomson's Chemistry, in four volumes after the fifth London Edition*, Phila. 1818. He alludes in his preface to the fact that "four systems of Chemistry had been published in England, each of them possessing considerable merit." From the information that can be gathered it would seem that the system of Thomson

> ultimately obtained the greatest share of public approbation, not only in England and on the European Continent . . . It was a happy combination of chemical facts and chemical doctrines; very extensively applied to the useful purposes of medicine, the arts, and manufactures.

These reasons influenced Cooper in making an American edition. He was enthusiastic in his task; but, as was characteristic of him differed in many points from his author, saying

> His (Thomson's) well earned reputation will not be shaken by these remarks, even in my own opinion. The most able men are liable to err, and acknowledge it generally with a promptitude in direct proportion to their real merit.

Thomson in this new edition gave "a very full development and illustration of the atomic theory, and the doctrine of definite proportions." He accepted Dalton's views, and was the first to give place to the same in a printed text. Cooper, in a foot-note, emphatically declares

> the atomic theory was first stated and explained by Dr. Bryan Higgins in 1789.

It amuses one, in scrutinizing the earlier chemical texts on chemistry, to observe how frequently Higgins is drawn into the discussion as the originator of the chemical atomic doctrine. The English chemical fraternity was divided on this question. Dr. Cooper quite naturally allied himself with those who regarded Higgins as the true promulgator of the idea, and at various places spoke in plain terms on the subject. Those controversial days, however, have passed and need not be lingered upon.

The text of Thomson is most satisfactory. The theories of the day are admirably presented. The non-metals and metals are given full consideration. The reader will recall, on reading the following quotation, his own attempts at heating together copper and sulphur.

> The mixture first melts, then a kind of explosion takes place; it becomes red hot; and when taken from the fire, continues to glow for some time like a live coal. If now we examine it, we find it converted into *sulphuret of copper*.

And, teachers reading these lines are merely reading what they have done again and again. Thomson tells that

> this curious experiment was first made by the associated Dutch chemists, Dieman, Troostwyk, Niewland, Bondt and Lurenberg in 1793. They found the combustion succeeds best when the proportions are 3 parts of sulphur and 8 parts of copper filings.

The names of the proposers of many experiments given in the text are introduced. This is one method of introducing the personal element, and vitalizing the text.

Minerals were discussed at length although "the whole science of mineralogy had been created since the year 1770."

The fourth volume of Thomson's treatise is devoted to the consideration of vegetable and animal substances; in short, to organic chemistry. Descriptive matter and discussions are clear and thoughtful.

Students of chemistry in the early days of the nineteenth Century must have found Thomson's book a very great help. It was the product of one intensely interested in chemistry, and animated with an eager desire to win the closest attention of the neophyte in the science.

The discussions of affinity, caloric and light are succinct and very lucid.

The story of the discovery of Prussic acid and Prussian blue is bound to have the reader's closest thought. But, today, who cares how early chemists acquired their knowledge of the constitution of many of our simplest and most useful chemical bodies?

Berthollet said of Thomson's Chemistry—

> It is unrivalled as a Thesaurus of every known fact of importance connected with chemistry, and as containing the most accurate account of the history of every known substance. Indeed, from the extreme regularity and methodical precision characterizing the work, from the cool discrimination with which every subject is weighed and treated of according to its relative importance, and from the accurate historical detail prevailing throughout, there is at this moment no system of the science of chemistry in which so complete and extended information on every topic is to be found organized and detailed as in Thomson's chemistry; which is evident from its having already reached the sixth large impression; and from its having long ago passed into the laboratory of the Frenchman and the German on the continent of Europe, and of the Armenian in Asia; while it has been reprinted for the use of the American student.
>
> —A System of Chemistry, in four volumes. By Thomas Thomson. From the 5th London edition, with notes, By Thomas Cooper, M.D., Professor of Chemistry and Mineralogy in the Faculty of Arts of the University of Pennsylvania. Philadelphia: Printed and published by Abraham Small, 1818.

JOHN GORHAM

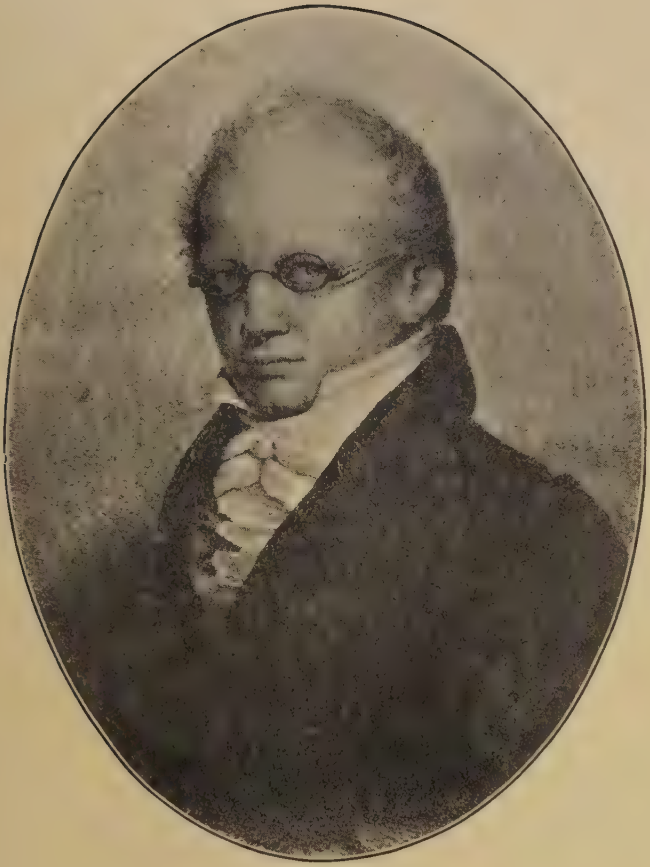
A chemistry which came but recently into the writer's possession was that written by *John Gorham* of Harvard University. It appeared in 1819 in two volumes. Gorham said his work was a compilation, with no pretensions to originality, and that

> he submitted it with much diffidence to the public, as it is the first original work of the kind which has been published in the United States.

Did Gorham never see the *Syllabus* of Benjamin Rush, printed in 1771, or Cutbush's two volumed *Philosophy of Chemistry*, in 1813? (P. 47.)

However, the publication of Gorham was intended as a textbook to accompany "the lectures delivered by him to the medical students and undergraduates of Harvard University." The effort was also made by the author

> to adapt it to the class of readers who might wish to acquire a knowledge of the laws of chemistry without entering much into its practical details.



John Gorham.

Face p. 60

It was hoped that it would find place between Henry's Chemistry, "better adapted to the laboratory than the closet" and the "more elaborate and profound systems of Doctors Thomson and Murray."

Its introduction is practically a condensed history of the science. All reference and discussion of mineralogical and geological topics, so noticeable in earlier works, are omitted.

It is very readable and contains a vast fund of information, so much, indeed, that the question forces itself as to whether it was not too exhaustive for those for whom it was primarily prepared. College and Medical students of 1819 must have had before them the seriousness of their life work, or were quite willing to labor, if their instructors thought it for their best interests.

Gorham's book exerted a marked influence, not at all limited to New England, for copies are found now and then far from where the book was written and published.

Silliman, the Elder, said of the Gorham text

> Perhaps this work may be regarded as occupying a niche not exactly filled before. It does not claim to present a system of chemical knowledge with the fullness of the great works of Fourcroy, Thomson, Murray and Thenard, but among the works of middling or minor size—as those of Brisson, Jacquin, Heron, Park, and the Conversations on Chemistry—La Grange and the abridgements of Thomson and Murray, Chaptal, Lavoisier, Accum, Brande, it has, we believe, a right to claim a peculiar character as being more full than any of them, and more philosophical than most of them . . . The work is not surpassed by any one with which we are acquainted, as a perspicuous, chaste and philosophical treatise.

The book makes a strong appeal. Time devoted to its study will not be lost. Its author was broadly informed on chemistry and displayed splendid judgment in the presentation of his material. It is a treasure in the chemical literature of America. The author had studied in Edinburgh, and it was a loss when at 46 years of age he passed to the great Beyond.

Although having long sought and inquired for the Gorham text, the writer first saw and read a copy of it in the State Library at Harrisburg, Pa. An afternoon passed all too soon in examining its pages, and when other duties intervened and obliged him to abandon it, it was with real reluctance that he laid it aside. Then followed years, until, on a visit to Georgetown, Kentucky, a second copy came to notice—probably once the property of an early teacher who had received his training at Harvard. The date of printing, on the title page, made plain that the Gorham text had passed through more than one edition; hence, a previous statement, viz., that the book exerted a wide influence.

In this connection, chemists will probably enjoy the perusal of a letter from President Adams to Dr. Gorham when he assumed the Erving Chair of Chemistry in Harvard:

Quincy, Jan. 28, 1817.

Sir:

My thanks are due to you for your inaugural Address of Dec. 11th.

I rejoice that such a Professorship is established and that so accomplished a Professor has been chosen.

I am afraid to express my wild ideas on this subject. We are all Chymists from our cradles. All mankind are Chymists from their cradles to their graves.

The Material Universe is a chymical experiment. Its author and conductor is now, ever was, and ever will be, the only perfect Chymist in the universe. I believe he constantly superintends the operation and interposes whenever, if ever, his Special Providence is necessary and beneficial.

Our terrestial Chymists have a great controversy to decide between the Spiritualists and Materialists. Will your Telescopes, Microscopes, Incision Knives and Analyses ever penetrate to the original Atoms, the smallest particles of which this great chymical process is composed?

What is the first cause of motion? Is it Spirit or is it Matter? Some Philosophers, antient and modern, say "Spirit is a mere Metaphysical Hypothesis, a mere Chimera."

I say that Matter is a mere metaphysical abstraction, a mere hypothesis, a chimera. We know no more of Matter than we do of Spirit. We know nothing of either, but their qualities and effects. And we can see no compatibility between Perception, Memory, Judgment, Reason and Order; with Extension, Solidity and Vis Inertiae.

Can you Chymists discover any possible or conceivable connection between Sensation and Reflection and Matter and Motion? Modern Philosophers say Spirit is a word void of sense. I say Matter is a word void of sense. D'Alembert himself, when he was asked in writing, "What is Matter?" answered in writing, "Je n'en scais rien." And every Chymist of you all must give the same answer.

When and how shall we discover the smallest Particles of Matter in the Universe? When and how shall we discover the original causes of the mysterious diversity of odours and flavours; consider the odour of the Apple, the Quince, the Lime, the Lemon, the Orange, the Strawberry, the Raspberry, the Thimbleberry, the Pine Apple, the Grape, the Pennyroyal, the Saffron, the Balm, the Sage, the Mint, the Tansy, the Cresses, the Sorrels, the Mallows, the Roses, the Blossoms, the Lilies, etc. etc. etc. without number? Are they globular, triangular, quadrangular, cubes, cones, obelisks, pyramids, ellipses, or what? Do their perfumes and flavours and different medicinal qualities depend upon their different modifications and combinations, and what are they?

What is the difference between Small Pox and Kine Pock? This must be Chymical. What shall we say of Heat and Light? Wave the former for the present and think of the latter. A Sperma Ceti candle placed on a steeple on the great Blue Hill would be seen two miles, at least. A small portion of Sperma Ceti, therefore, converted into light, must fill a sphere of four miles diameter, with matter, if light is matter, and so full, that the human optick nerve can discern it in every part of that sphere. How attenuated must that matter be?

To pass by the Sun, Moon, and Planets, look at the fixed stars. My friend Herschel, I think, computes sixty or seventy millions of them discernible through his telescope. That we may not lose ourselves in this wilderness of suns, we will fix upon Sirius. I have not time to look into books of astronomy to ascertain his distance: say one hundred millions of miles. The light of Sirius, then, must be visible through his telescope in every part of a sphere two hundred millions of miles in diameter, at all times of the day, night, year and age. Who is the Chymist who has levigated this light with his pestle in his mortar? Mathematicians have demonstrated the infinite divisability of matter. The Marquis de l'Hospital has demonstrated the existence of quantities "infinitely little," and of other quantities infinitely less than those infinitely littles. What pretension can we have to limit the power of the first Chymist, and suppose that he has desisted at any imaginable minuteness, and fixed any definite magnitude or form of original and unchangeable particles of matter?

In former times, when I looked a little into Classicks, and a very little indeed it was, while I was fascinated with the Numbers of Lucretius, I could not comprehend his Atoms. In aftertimes, when I was delighted with the eloquence of Buffon, I could not help laughing at his Molecules.

Both appeared to me, as ridiculous as the Entities and Quidities of a more ancient Philosopher.

Chymists! pursue your experiments with indefatigable ardour and perserverance. Give us the best possible Bread, Butter, and Cheese, Wine, Beer and Cider, Houses, Ships and Steamboats, Gardens, Orchards, Fields, not to mention Clothiers or Cooks. If your investigations lead accidentally to any deep discovery, rejoice and cry "Eureka!" But never institute any experiment with a view or a hope of discovering the first and smallest particles of Matter.

I believe with Father Abraham and Sir Isaac Newton in the existence of spirit distinct from matter and resign to the Universal Spirit the government of his heavens and earth.

I pray you consider this letter as confidential. If it should get abroad, I should be thought a candidate for the new Hospital, before it will be ready to receive

Your obliged servant
JOHN ADAMS

Professor Gorham

—The Elements of Chemical Science. In two volumes with Plates. By John Gorham, M.D. Member of the American Academy, and Professor of Chemistry in Harvard University, Cambridge, Boston: Published by Cumming and Hilliard, at the Boston Bookstore, No. 1, Cornhill—University press . . . Hilliard & Metcalf—1819.

JANE MARCET

One of the most delightful chemical texts which circulated abroad and in America the first half of the 19th Century was styled "Conversations on Chemistry." It is sometimes seen in second hand bookstores and in old libraries. It was of English birth, the first edition appearing in London about 1805, and then at frequent intervals for more than a half century. The author—Mrs. Jane Marcet—adopted the conversational, dialogue form in presenting her material. Those participating were Mrs. Bryan, Caroline and Emily, her pupils. A few introductory paragraphs will show the plan:

Mrs. B. Having now acquired some elementary notions of Natural Philosophy, I am going to propose to you another branch of science, to which I am particularly anxious that you should devote a share of your attention. This is *Chemistry*, which is so closely connected with Natural Philosophy, that the study of the one must be incomplete without some knowledge of the other; for it is obvious that we can derive but a very imperfect idea of bodies

Jane Marcet.

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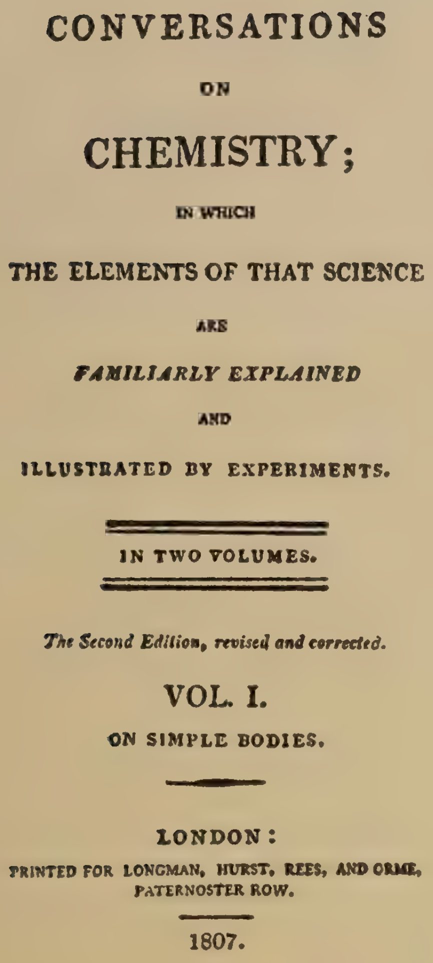

CONVERSATIONS

ON

CHEMISTRY;

IN WHICH

THE ELEMENTS OF THAT SCIENCE

ARE

FAMILIARLY EXPLAINED

AND

ILLUSTRATED BY EXPERIMENTS.

IN TWO VOLUMES.

The Second Edition, revised and corrected.

VOL. I.

ON SIMPLE BODIES.

LONDON:
PRINTED FOR LONGMAN, HURST, REES, AND ORME,
PATERNOSTER ROW.

1807.

> from the study of the general laws by which they are governed, if we remain totally ignorant of their intimate nature.
>
> *Caroline*—To confess the truth, Mrs. B., I am not disposed to form a very favorable idea of chemistry, nor do I expect to derive much entertainment from it. I prefer those sciences that exhibit nature on a grand scale, to those which are confined to the minutiae of petty details.
>
> *Mrs. B.*—I rather imagine that your want of taste for chemistry proceeds from the very limited idea you entertain of its object. You confine the chemist's laboratory to the narrow precincts of the apothecary's shop, while it is subservient to an immense variety of other useful purposes. Beside, my dear, chemistry is by no means confined to works of art; Nature also has her laboratory, which is the universe, and there she is incessantly employed in chemical operations. You are surprised, Caroline, but I assure you that the most wonderful and the most interesting phenomena of nature are almost all of them produced by chemical powers . . .
>
> *Caroline*—If this is the case, I have certainly been much mistaken in the notion I had formed of chemistry. I own that I had thought it was chiefly confined to the knowledge and preparation of medicines.
>
> *Mrs. B.*—That is only a branch of chemistry which is called Pharmacy; and though the study of it is certainly of great importance to the world at large, it properly belongs to professional men, and is therefore the last that I should advise you to study.
>
> *Emily*—But did not the chemists formerly employ themselves in search of the Philosopher's Stone, or the secret of making gold?

In this fashion more than six hundred duodecimo pages, comprising twenty-three *Conversations*, are the facts of chemistry given. For example: *Conversation* 2 discusses Light and Heat, *Conversation* 4 treats of Specific Heat, Latent Heat and Chemical heat; *Conversation* 8 of Carbone; *Conversation* 10 of Alkalies; *Conversation* 11 of Earths; *Conversation* 17 of the Nature and Composition of Vegetables; *Conversation* 19 of History of Vegetation, &c., &c.

Many interesting facts cluster about this little book. Its editions were numerous, not only in the home land but in this country, where it was authoritatively stated that more than 160,000 copies were sold before 1853.

An enthusiastic admirer wrote:

> No work on science in the English language, perhaps in the world, has been more useful in imparting its knowledge. Its clear elucidation, and its

> admirably simple method, have contributed, in a great degree, to render chemistry popular in America as well as in England, by presenting the leading facts of that science so plainly illustrated as to be within the reach of ordinary minds.
>
> Men must be taught as though we taught them not.
>
> We women have to bear that in mind, when we find many of the learned spurning the idea of a female philosopher, while the foundation of their own science has been made by the *Conversations on Chemistry*, which book has for more than thirty years been the general text-book for young men in Great Britain and in the United States.

For a long time it was customary to speak of the book as "Mrs. Bryan's Conversations."

Many American publishers issued editions, supervised by some eminent native chemist. In 1809, Increase Cooke & Co., Booksellers of New Haven published the two volumes in one and on their title page added to the usual name:

> A Description and Plate of the Pneumatic Cistern of Yale College &c.

thus suggesting Silliman, the Elder, as directing editor; while in 1818 Thomas Cooper, M.D., of the University of Pennsylvania, gave to the public his revised edition, mentioning in the preface:

> This is a very elegant and a very useful compilation; I have endeavoured to contribute nothing to its elegance, but something to its usefulness.

And, William H. Keating, in presenting the tenth American edition in 1824, in Philadelphia, wrote:

> The popularity and success which have attended the interesting and useful work which we republish are the surest proofs of its merits. It has already gone through eight editions in England and nine in America, and the demand for it appears still to be as great as ever . . . It has met with great and well merited success.

In 1822, 1826, 1829 and 1831, editions appeared in Hartford, Connecticut, under the editorship of Dr. J. L. Comstock, who remarked:

> This is one of the most popular treatises on chemistry which has ever appeared. The elegant and easy style, also, in which the authoress has

managed to convey scientific instruction is peculiarly adapted to the object of the work.

Thomas P. Jones, M.D. of Columbian College, Washington, D.C. was another who entered the lists with the "Conversations" in 1831.

None of these editors ventured to make serious alterations. An indignant adorer of Mrs. Marcet said:

> It is curious to notice the way in which American *men* have availed themselves of this treasure of intellect without remuneration . . . and on the title page have paraded their names in full without an intimation there, or in the preface, that the book was the production of a *lady!*
>
> Give her the fruits of her hands and let her own works
> praise her in the gates,
>
> is the command of God respecting women. In regard to Jane Marcet, this just tribute has been wholly withheld; yet few scientific writers have so well merited the praise and gratitude of all who read the English language.

And, another who rushed to the defense of Mrs. Marcet added:

> We are informed by one of the American editors of this work that his reason for not placing the name of Jane Marcet on the title-page, was because scientific men believed it fictitious!

But nowhere has been discovered a complaint from the authoress herself.

It has often been said that Davy's greatest discovery was Michael Faraday. Can that be true in the light of the following letter from the immortal Faraday to de la Rive:

> Mrs. Marcet was a good friend to me, as she must have been to many of the human race. I entered the shop of a Book-seller and book binder at the age of 13, in the year 1804, remained there eight years, and during the chief part of the time bound books. Now it was in those books, in the hours after work, that I found the beginning of my philosophy. There were two that especially helped me, "the Encyclopaedia Brittanica," from which I gained my first notions of electricity, and Mrs. Marcet's "Conversations on Chemistry," which gave me my foundation in that science.
>
> Do not suppose that I was a very deep thinker, or was marked as a precocious person. I was a very lively, imaginative person, and could believe in the "Arabian Nights" as easily as in the "Encyclopaedia;" but facts were

> important to me, and saved me. I could trust a fact, and always cross-examined an assertion. So when I questioned Mrs. Marcet's book by such little experiments as I could find to perform, and found it true to the facts as I could understand them, I felt that I had got hold of an ancor in chemical knowledge, and clung fast to it. Hence my deep veneration for Mrs. Marcet: first, as one who had conferred great personal good and pleasure on me, and then as one able to convey the truth and principle of those boundless fields of knowledge which concern natural things, to the young, untaught, and inquiring mind.
>
> You may imagine my delight when I came to know Mrs. Marcet personally; how often I cast my thoughts backwards, delighting to connect the past and the present; how often, when sending a paper to her as a thank-offering, I thought of my first instructress, and such like thoughts will remain with me.

For years the writer has been assembling the "Conversations." It has been his hope that in time he might have a copy of each English edition and one of every American edition of this remarkable little book. In a small way his ambition has been realized. The earliest editions of "Conversations" in his possession are the second London edition (1807) and the second American (1809). The latter was published by James Humphreys. The name of the editor does not appear, but as the title-page mentions the "*Hydro-pneumatic Blow-pipe* invented by Mr. Joseph Cloud of the Mint of the United States" suspicion arises that Mr. Cloud very likely acted as editor of this edition. He believed that he had simplified the compound blowpipe of Robert Hare. This view, however, was not shared by many chemists of the time, and, indeed, Cloud's discovery has practically been forgotten.

Efforts to disclose an autograph letter of Jane Marcet have been fruitless. One would love to scan a letter penned by her.

Well, as to Mrs. Marcet,—a woman of extraordinary talents and learning! She was the only daughter of Francis Haldemand, a rich Swiss merchant, established in London. It was December 4, 1799, that she married the eminent Dr. Alexander Marcet. She had been carefully reared and her education was broadly laid. She loved to write and particularly for young folks. She wrote familiarly on scientific subjects at a time when simple scientific textbooks were almost unknown. Her "Conversations on Political Economy" was reputed to have been her most famous book. It was reprinted many times. Lord Macauley said:

> Every girl who has read Mrs. Marcet's little dialogues on political economy can teach Montagu or Walpole many lessons in finance.

McCulloch held

> that on the whole Mrs. Marcet's book is the best introduction to the science that has yet appeared;

and Jean Baptiste Say, the eminent French economist

> praised Mrs. Marcet as the only woman who had written on political economy and shown herself superior even to men.

She was truly a versatile person for she wrote successfully on a number of subjects. As an introduction to her work on chemistry she prepared "Conversations on Natural Philosophy." It was a familiar exposition of the first elements of that science. It was successful and in its 14th edition was revised and edited by her son Francis Marcet, F.R.S., professor at Geneva and author of *Cours de physique Experimentale*, 1831.

Harriet Martineau, a devoted friend of Mrs. Marcet, said the latter had

> a great opinion of great people; of people great by any distinction—ability, office, birth and what not; and she innocently supposed her own taste to be universal. Her great pleasure in regard to me was to climb the two flights of stairs at my lodgings (asthma notwithstanding) to tell me of great people who were admiring or at least reading my *Series*. She brought me "homages" and all that sort of thing from French savans, foreign ambassadors, and others.

Chemists will revere Mrs. Marcet's memory. For their science, and her science, she performed a noble, never to be for-

James Freeman Dana.

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gotten service. On June 28, 1858, at the age of 89, she passed quietly away in the home of her son-in-law.

—Conversations on Chemistry; in which the Elements of that science are familiarly explained and illustrated by experiments—in two volumes. The second edition, revised and corrected. London: Printed for Longman, Hurst, Reeds and Orme. Paternoster Row—1807.

JAMES FREEMAN DANA

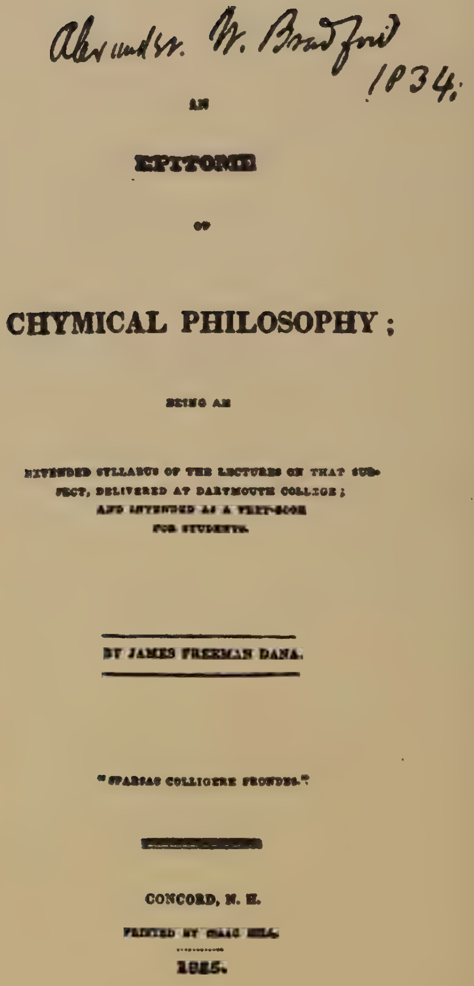
The text-books thus far considered have been without exception rather exhaustive and large volumes. It was the custom to so exhibit the science. However, condensations and syllabi did appear at intervals. Among these was "*An Epitome of Chemical Philosophy*—by James Freeman Dana." It possessed decided merit, and in the immediate years of its appearance exercised great influence in New England communities. Its declared purpose was to be

> a work which should be useful as a Text Book of the science, as it is usually taught in our academies and colleges.

It is an attractive text, well written and with a concise manner of presentation of the essentials of the science. It is interesting to read that—

> Very few products of organic bodies can be found by the artificial processes of the Laboratory. Their elements are united by a power which subverts and controls the ordinary laws of chymical affinity; they are united and retained in union by *Vital Affinity*, a term happily introduced by Prof. J. Jackson, M.D. of Boston. As soon as life ceases, under ordinary circumstances, the elements of organic bodies become subjected to the influence of the usual laws of affinity.

This all was, of course, before Wöhler's memorable synthesis in 1828. Now such textual matter would be termed, on many sides, to be "rubbish." It is pure "junk!" It should find no place but the scrap heap! Yet, reading it and calmly passing in review the marvelous changes and discoveries which a century has unfolded, there come to us—even to those in whom there rests but a scintilla of reverence for the past—a feeling of grati-



Alexander W. Bradford
1834.

AN

EPITOME

OF

CHYMICAL PHILOSOPHY;

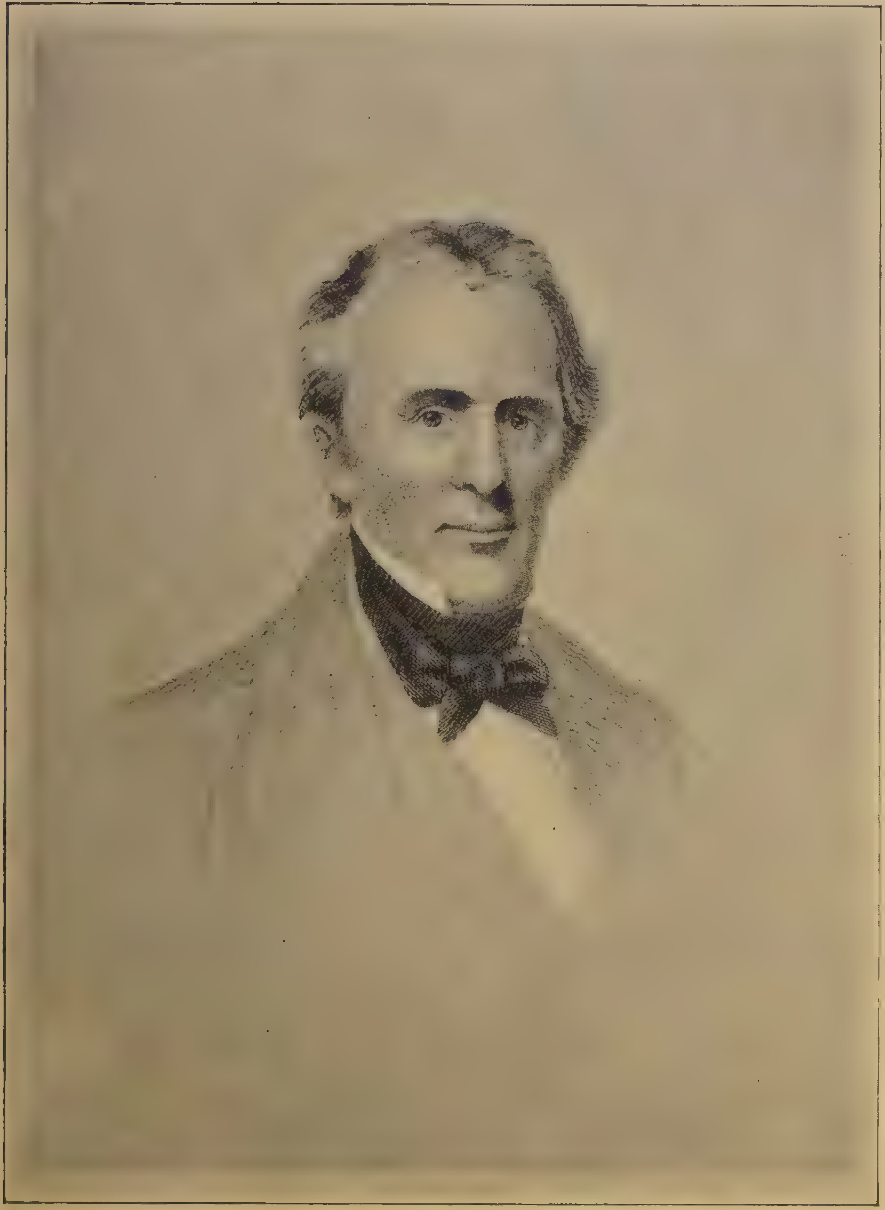
BEING AN

EXTENDED SYLLABUS OF THE LECTURES ON THAT SUBJECT, DELIVERED AT DARTMOUTH COLLEGE;
AND INTENDED AS A TEXT-BOOK
FOR STUDENTS.

BY JAMES FREEMAN DANA.

"SPARSAS COLLIGERE FRONDES."

CONCORD, N. H.
PRINTED BY ISAAC HILL.
1825.



Benjamin Silliman, the elder.

Face p. 72

tude to the fathers who so patiently struggled in their laboratories and with their pens to set forth the possibilities and usefulness of our science. We love to read their books (now old books), enjoying their manner and methods of presenting our common science to the students of their day, who probably saw them (or imagined they did) as we see now immense quantities of "junkable" literature (written long before their time). But who knows—maybe all these very early writers of chemical text-books were moved as were the editors of the "Essays of Natural Experiments made in the Academy of Del Cimento in 1657" when they announced they would not have

> put them (the Essays) forth had we not been much urged thereto by Persons Meriting from us, by their dear importunities, the Sacrifice of a Blush, for exposing such imperfect Embrics.

An Epitome of Chymical Philosophy; being an extended Syllabus of the lectures on that subject, delivered at Dartmouth College; and intended as a text-book for students. By James Freeman Dana, Concord, N. H. Printed by Isaac Hill. 1825.

BENJAMIN SILLIMAN, THE ELDER

In 1830, Silliman's *Elements of Chemistry*, in two volumes, made its appearance. It followed the order of lectures given in Yale College by the distinguished author. There are many interesting paragraphs in the preface. They tell much; hence, several of them will be given:

> Exact accounts of processes and manipulations have been given; and Dr. Hare, having kindly permitted the introduction of the cuts, from his Compendium, his own language, sometimes abridged, has been generally employed in the description of his figures. The valuable illustrations thus derived from his liberality, render it unnecessary to apologize for the frequent use of his name . . . The materials of this work have been gradually accumulating since 1802. They have been drawn from the scientific Journals, from the Transactions of the learned societies, and from the principal writers who have flourished since the middle of the last century—*the Augustan Age of Chemistry*. From works of an earlier date, light has been occasionally derived, as well as from notes and recollections of the instructions of the distinguished teachers, to whom the author was formerly so happy to listen. In this view, he takes particular satisfaction in naming the late Dr. Murray

> of Edinburgh and Professor Thomas C. Hope, still distinguished ornament of the University in the same city . . . In the immediate preparation of this work for the press, the original memoirs of authors and discoverers have often been consulted . . . There are, however, some works to which a more particular acknowledgment is due. Those of Bergmann and Scheele; the lectures of Dr. Black by Robison; the System by Dr. Thomson, in all its editions, and also his more recent work on the first principles of chemistry; the Dictionaries of Nicholson, Aikens, and Ure; the Compendium of Dr. Hare, the Dispensatory of Dr. Coxe, the Technology of Dr. Bigelow, the Operative Chemist of Gray, and the Chemical manipulation of Mr. Faraday; the System of the late Dr. Murray . . . and also the writings of Mr. Dalton; the works of Lavoisier, Chaptal, Berthollet, and Fourcroy . . . the writings of Dr. Priestley, Bishop Watson, Mr. Parkes, Prof. Berzelius, and Sir H. Davy— are among the leading authorities, etc., etc.

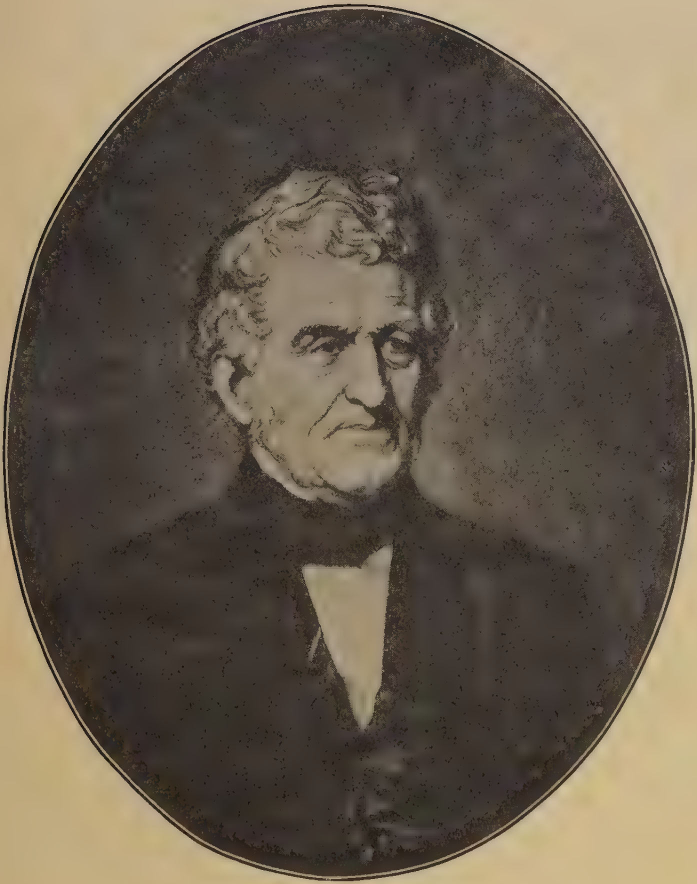
And besides he wrote:

> But the work to which more than any other, the author of this is indebted, is the *Elements* of Dr. Henry . . . no writer on chemistry, in the English language, surpasses Dr. Henry in fidelity, perspicuity and good judgment.

Is not this a splendid tribute to his masters! And, in the full spirit of Silliman this arduous and responsible work was written and printed "under the unremitting pressure of absorbing and often conflicting duties. Life is flying fast away, while, in the hope of discharging more perfectly our obligations to our fellowmen, we wait in vain, for continued seasons of leisure and repose, in which we may refresh and brighten our faculties, and perfect our knowledge. After we are once engaged in the full career of duty, such seasons never come; our powers and our time are placed in incessant requisition; there is no discharge in our warfare; and we must fight our battles not in the circumstances and position which we would have chosen, but in those that are forced upon us, by imperious necessity."

Those were the lines written by a grand old man, a superb teacher, when he launched his own text-book of chemistry—excellent in so many respects!

In turning its pages one encounters much of arresting interest, for example, in telling of the making of nitric acid, the procedure of Cavendish is cited as consisting—



Robert Hare.

in *electrolyzing* for a great length of time, with many thousand shocks, *a mixture of oxygen and nitrogen gas*, in the proportion, by measure of 5 pts. of oxygen to 3 of common air, or 7 oxygen to 3 nitrogen, or common air by itself. It may be done over quicksilver in a glass tube, furnished with gold or platinum wires; caustic potash, introduced before electrization, will absorb the acid as it is formed, and thus nitre will be produced, from which the acid may be extracted. Mingled in proper proportions, the gases nearly disappear, in consequence of their combination.

The numerous foot-notes in this chemistry are laden with most delightful explanatory material. At present college text-books of chemistry are not so voluminous as this product of Silliman. Presumably there is lack of time for such a complete presentation of the science. Yet, this very voluminosity attracts. The book is undeniably excellent and served in its day a noble purpose, and did great good.

The high praise Silliman accords the text-book of Henry is seen in an additional reference to it:

For twenty years, his work was the text-book of the classes in Yale, and it ceased to be used here only when, on account of its increased size and cost, it ceased to be reprinted. Three editions of it (besides two subsequently by Coxe and Hare) with notes were published expressly for the students of Yale College. There have been three English editions since the last American.

—Elements of Chemistry, in the order of lectures given in Yale College. By Benjamin Silliman, Professor of Chemistry, Pharmacy, Mineralogy and Geology—in two volumes, New Haven. Printed and published by Hezekiah Howe. 1830.

ROBERT HARE

The *Compendium of Chemistry* by Robert Hare was a remarkable text-book. It passed through four or five editions. It was most comprehensive,—including much elementary physics.

The preface is interesting. It will be recalled that Hare had been lecturing for about ten years, so that he was moved to say:

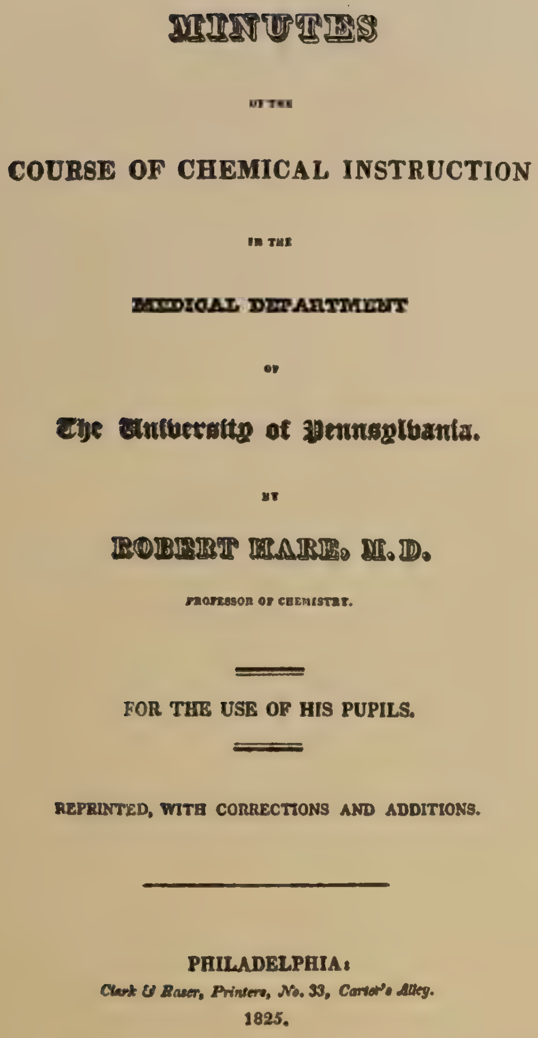
Where a subject cannot be followed by a reader without *study*, it would seem unreasonable to expect that, without some assistance, it should be followed at a lecture . . . so I applied myself to improve and multiply the means and methods of experimental illustration, as to render manipulation

> easier, and the result more interesting and instructive. But, notwithstanding all my efforts, there remained obstacles to be surmounted. However striking might be the experimental illustration of a property or principle, the rationale might be incomprehensible to a majority of my class, unless an opportunity for studying it were afforded them . . . Again, some of my contrivances, which greatly facilitated my experiments, were too complex to be understood without a minuteness of explanation, which even if it were useful and agreeable to some of my hearers, might be useless and irksome to others; and to such minutiae I have not deemed it expedient to exact attention.

Such are a few of his reasons for publishing the *Compendium*, which had been antedated by his *Minutes*, an excellent syllabus designed for student use.

The *Compendium* was decidedly original. The illustrations with few exceptions were made from apparatus devised by Hare himself. In it one observes the beginnings of gas analysis, the forerunners of apparatus employed by the brilliant Hofmann in the determination of the constitution of water, etc., the use of the mercury cathode in the electrolysis of metallic salt solutions, the first electric furnace ever constructed, in which calcium metal, phosphorus and calcium carbide were isolated or made. Hare was ever ready to discuss chemical theory. At different times he was in controversy with Liebig and Berzelius on the question of the constitution of bodies. Many will recall that some years ago the keen observer Remsen set forth in the American Chemical Journal views relative to the constitution of double halides. On submitting his communication to Wolcott Gibbs, the latter recommended that he turn to Hare's *Compendium*. This he did and found that he had been antedated in his views on double halides.

The *Compendium* has been seen on the shelves of many libraries scattered about the United States. It was a very sane book written by one who had delved deep in the mysteries of his favorite science. It was primarily for students in medicine. They probably thought it a difficult text. That would be the verdict upon it today. But if it were before or after the lectures customarily submitted by its author its rare value would be most



MINUTES

OF THE

COURSE OF CHEMICAL INSTRUCTION

IN THE

MEDICAL DEPARTMENT

OF

The University of Pennsylvania.

BY

ROBERT HARE, M.D.

PROFESSOR OF CHEMISTRY.

FOR THE USE OF HIS PUPILS.

REPRINTED, WITH CORRECTIONS AND ADDITIONS.

PHILADELPHIA:
Clark & Raser, Printers, No. 33, Carter's Alley.
1825.

apparent. Hare loved to struggle with difficult things, so it was not to be expected that he would write an easy text.

The writer has repeatedly read the different editions of the *Compendium*, hoping to discover the spirit of its distinguished author, and has invariably concluded that the book was unique—just as unique as Robert Hare himself—and original as few other books on descriptive chemistry have ever been. It has been his rare privilege to converse with several of the very early students of the Lawrence Scientific School, who informed him that although in their day the *Compendium* was out of date, Wolcott Gibbs invariably recommended it to them. Could it have been affection alone for his old chief and master that led Gibbs to make this recommendation?

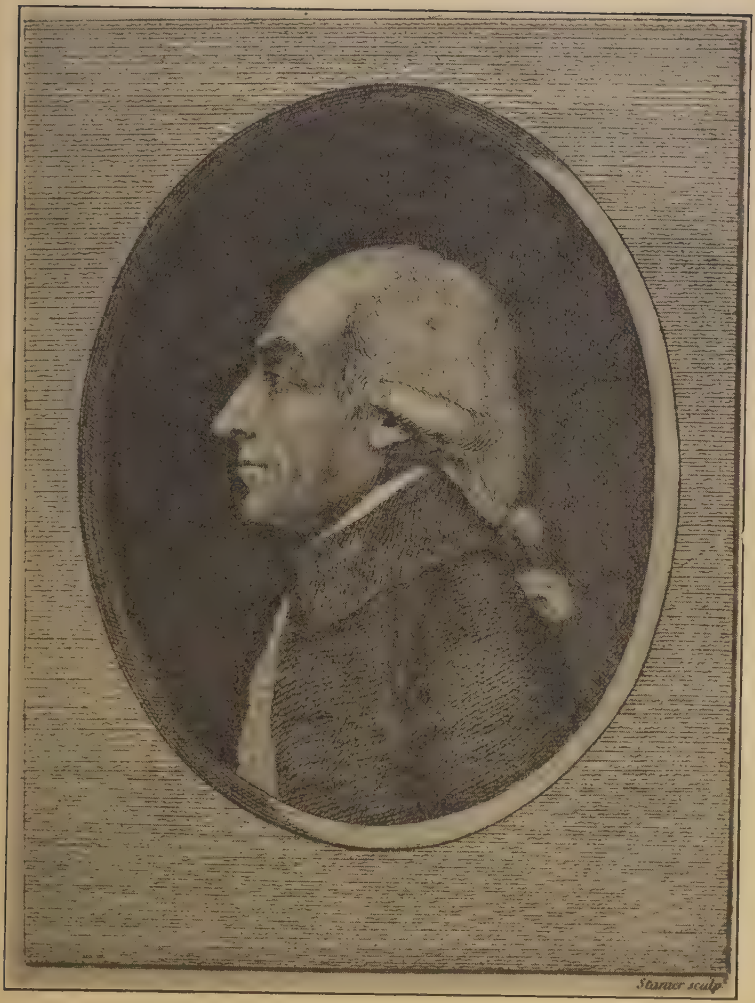
Robert Hare and Wolcott Gibbs were true chemical philosophers. They possessed to an astounding degree the power of generalization. They were two of America's most brilliant chemists.

—A Compendium of the Course of Chemical Instruction in the Medical Department of the University of Pennsylvania by Robert Hare, M.D. Professor of Chemistry. Philadelphia. J. G. Auner, No. 333 Market St. 1827.

JOSEPH BLACK

In the last quarter, or perhaps better, in the second half of the 18th Century, quite a number of Americans found Edinburgh an excellent center for scientific studies. There, among others, Joseph Black unfolded before them the mysteries of chemistry and thereby made a Scotch imprint on America in that particular science. Such being the case, the following letter does not surprise one:

> The high estimation in which we hold the lectures of Dr. Black induces us cordially to recommend them to the friends of chemical science . . . Declining any invidious discussions or comparisons respecting the discoveries of their illustrious author, with some fancifully described to earlier chemists, or arrogated by his contemporaries—we believe that lucid arrangement, strength of argument, and excellence of experimental illustration, render


Stainer sculp.

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them more instructive to the student and more gratifying to the proficient than most other publications in that department of physical enquiry.

(Signed) James Reynolds, M.D.
Adam Seybert, M.D.
Phila. Dec. 13, 1806. Ben. S. Barton, M.D.

Such are the sentiments of three Americans, one of whom (Adam Seybert) at least, was a very excellent chemist, whose training had been broadened by studies in Paris and in Germany.

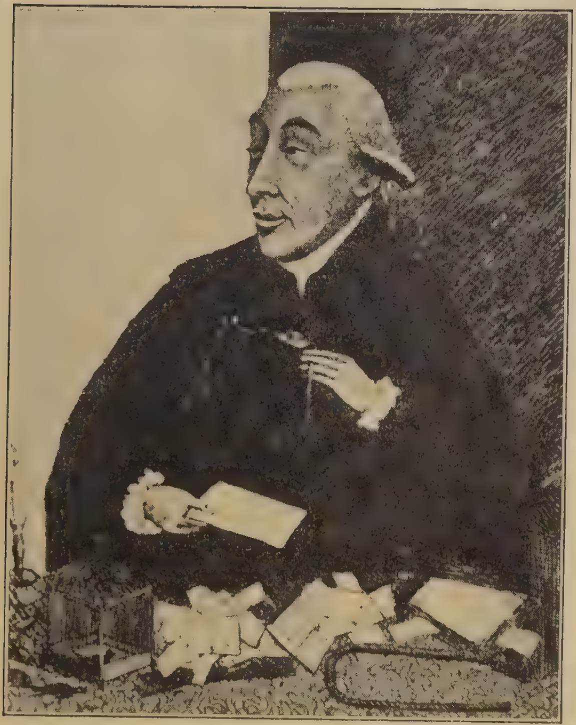
This eulogistic expression was an advertisement in the first American edition of Black's Chemistry published by Matthew Carey. It was an endorsement of the publication; as, was also a list of "Subscribers' Names," given in the first volume. These resided in all parts of the union on the Atlantic Coast. The book, therefore, became widely known. It must be remembered that Black did not write the book. This was done "from his manuscripts" by his successor and friend John Robison, who was charged, too, with this duty by Black's Trustees and Executors, and said

> When I then entered seriously upon the task, I found that the notes were (with the exception of perhaps a score of lectures) in the same imperfect condition that they'd been in from the beginning, consisting entirely of single leaves of paper in octavo, full of erasions, interlinings, and alterations of every kind; so that in many places, it was not very certain which of several notes was to be chosen. They were often in such a state, that I could not give them to my amanuensis to be transcribed; and the only thing that could be done was for me to dictate from them . . . This process necessarily consumed a great deal of time before I got to the end . . . Throughout the whole series of lectures, whenever the subject was very plain and obvious, the manuscript contained merely a memorandum, from which Dr. Black had lectured extempore; in many places, a reference was made to something standing on the table, or something going forward in the furnaces. All those blanks had to be filled up . . . I had the assistance of a very fair copy of notes, taken by a student, or rather manufactured by the comparison of many such notes . . . This copy belonged to Dr. Black, and he had made many alterations and insertions of whole pages with his own hand . . . On the whole, what follows in the text of this work, is the discourse of Dr. Black; as much as possible in his own words, and in every passage, a faithful exhibition of his sentiments and opinions.

And thus the Chemistry of Black was prepared. Black himself never thought of issuing a book. His pupils and friends did it for him. Such records of the great builders of our science are a blessing to those pursuing its development. One reads the Black text with ease. Each topic is adequately presented in clear and simple language. Lord Brougham in his "Lives of Philosophers of the Time of George III" says of Black as a teacher:

> His style of lecturing was as nearly perfect as can well be conceived; for it had all the simplicity which is so entirely suited to scientific discourse, while it partook largely of the elegance which characterized all he said or did . . . But still less can the reader rise from the perusal to any conception of the manner. Nothing could be more suited to the occasion; it was perfect philosophical calmness; there was no effort; it was an easy and graceful conversation. The voice was low but perfectly distinct and audible through the whole of a large hall crowded in every part with mutely attentive listeners; it was never at all forced anymore than were the motions of the hands, but it was anything rather than monotonous. Perfect elegance as well as repose was the phrase by which every hearer and spectator naturally, and as if by common consent, described the whole delivery . . . In one department of his lecture he exceeded any I have ever known, the neatness and unvarying success with which all the manipulations of his experiments were performed. His correct eye and steady hand contributed to the one; his admirable precautions, foreseeing and providing for every emergency, secured the other . . . The reader who has known the pleasures of science will forgive me if at the distance of a half century I love to linger over these recollections . . . I have heard the greatest understandings of the age giving forth their efforts in its most eloquent tongue—have heard the commanding periods of Pitt's majestic oratory,—the vehemence of Fox's declamation,—have followed the close-compacted chain of Grant's pure reasoning—been carried away by the mingled fancy, epigram, and argumentation of Plunket; but I should without hesitation prefer, for mere intellectual gratification . . . to be once more allowed the privilege which I in those days enjoyed of being present while the first philosopher of his age was the historian of his own discoveries, and be an eye-witness of those experiments by which he had formerly made them, once more performed with his own hands.

What a wonderful encomium of a modest teacher of chemistry, from an old student who himself held a place of honor and distinction!



Joseph Black.

The observations of Dr. Robison, usually in annotations at the conclusion of each of the several volumes, lay bare many facts worth knowing. Thus:

> He (Lavoisier) saw that he was about to operate a complete revolution through the whole extent of chemical science. He could not but foresee doubt and opposition on all hands. Confident of victory (after his happy employment of Mr. Cavendish's discoveries), the prospect was very flattering. I may perhaps add to this the genius and character of his nation. This is scarcely left in my choice,—for, almost at the first, the doctrines of Lavoisier were preached by the associated chemists as the system of *French Chemistry*. M. Fourcroy, Monge, de Morveau, and others, repeatedly give it this name, with some exultation. It was propagated as a public concern; and even propagated in the way in which that nation always chooses to act—by address and with authority. Everything pertaining to the system was treated in council, and all the leading experiments were documented by committees of the Academy of Sciences . . . Lavoisier saw that his theory of combustion depended on the doctrine of latent heat, and was extremely anxious to obtain Dr. Black's acquiescence. Learning, by the return of this gentleman, that Dr. Black thought well of his theory, and had introduced it into his lectures, he wrote to him again in July 14th, 1790, as follows:
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> "J'apprends avec une joie enexprimable, que vous voulez bien attacher quelque merite aux idées que j'ai professé le premier contre la doctrine de phlogistique. Plus confiant dans vos idées que dans les miennes propros, accoutumé a vous regarder comme mon maitre, j'etois en defiance contre moi même (credat Judaeus Apella) tant que je me suis ecarté, sans votre aveu, de la route que vous avez si glorieusement sulvie. Votre approbation, Monsieur, dissipe mes inquietudes, et me donne un nouveau courage. Je ne serai vontent jusqù a ce que les circumstances me permettent de vous aller porter moi même le temoignage de mon admiration, et de me ranger au nombre des vos desciples. La revolution qui s'opera en France devant naturellement rendre inutile une partie de ceux attaches á l'ancien administration, il est possible que je jouisse du plasir de la liberte: et la premier usage que j'en ferai, sera de voyager, et surtout en Angleterre, et a Edinburgh, pour vous y voir; pour vous ententre, et profiter de vos lecons, et de vos conseils."
>
> Dr. Black wrote him a very plain, candid, and unadorned letter in answer, expressing his acquiescence in his system. Mr. Lavoisier answered this by praising, in the highest terms, the elegance of the style, the profoundness of the philosophy, &c., &c. and begged leave to insert the letter in the *Annales de Chymie*. Dr. Black, who had been in very low spirits when he wrote that letter, and was much dissatisfied with its feebleness, was disgusted with what he now conceived to be artful flattery; and refused to grant the

request. Yet his letter appeared in that work before his refusal could reach Paris.

This wheedling, in order to extort from Dr. Black an acquiescence, on which he put a high value, for the influence which it would have on the minds of others, was surely unworthy of Lavoisier. Dr. Black was not only disgusted with the flattery, but seriously offended with its insincerity; and with a sort of insult on his common sense, by the supposition that he could be so wheedled, by a man whose publications never expressed the smallest deference for his opinions. For, by this time, Dr. Black had read Mr. Lavoisier's *Elements of Chemistry*, and the various dissertations by him and Mr. de la Place, published in the *Memoirs of the Academy*. His name is not once mentioned, even in the dissertations on the measures of heat, where his doctrine of latent heat is delivered and employed as the result of Mr. Lavoisier's own meditations. Nor is he named in those passages of the earlier dissertations, where the characters and properties of fixed air, and of the mild and caustic alkalis, are treated of. All appears to be the train of Mr. Lavoisier's own thoughts, for which he was indebted to no man. Such inconsistency with the deference expressed in the above cited letters, provoked Dr. Black to such a degree, that he resumed his critique on the nomenclature, and began to express his dissatisfaction with some parts of the theory, and his utter disapprobation of the unscientific and bullying manner in which the French chemists were trying to force their system on the world . . . But still notwithstanding the contempt which he expressed for the folly of a man who had tried, by fulsome and insincere flattery, to obtain what he had given him unasked, by teaching all his doctrines, Dr. Black considered the death of Lavoisier as a great loss to the science. He expected much from his penetration and sound sense; and he considered him as the only person who could keep his followers right, by checking their precipitant manner of proceeding.

Professor Lichtenberg, of Göttingen, a man of extensive and accurate knowledge in every department of natural science, gives an entertaining and instructive account of the introduction of these doctrines into Germany. It is to be found in his preface to the edition 1794, of Erxleben's Introduction to *Natural Philosophy;* as also in the *Literary Magazine of Gotha.* Great hesitation, doubt, and objections, were to be expected in Germany, the native soil of chemistry, and the resort of all who wished to perfect themselves in mineralogy. The new doctrines were even received with aversion and disgust. This, he says, was chiefly owing to the character of the nation from which they came. The Germans, who had been accustomed to consider themselves as the chemical teachers of Europe, could not bear to hear the opinions of their master, Stahl, treated with contempt; to be told by Frenchmen, living among them for instruction, that the principles of Stahl were such as no man could embrace who had a spark of common sense; to be told, in letters from

William James Macneven.

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France, that the principle of Stahl was a *mera qualitas;* a *mera contemplatio,* a fancy of the brain, which disgraced any man who entertained it for a minute; and to have it added, with saucy politeness, *dulci requiescat in pace!* But what most provoked them, was the pitiful triumphs of victory in which the French chemists indulged themselves. He says, that when the association had finished their experiments on the composition and decomposition of water, which filled up all the gaps of the system, they had a solemn meeting in Paris, in which Madame Lavoisier, in the habit of a priestess, burned on an altar Stahl's *Chemiæ dogmaticae et Experimentalis Fundamenta,* solemn music playing a Requiem.

Black's Chemistry never exercised the influence which attached to Henry's Chemistry, yet it held a unique place among our earliest text books, and animates one to his best when perused at this date. It was and is an excellent text for the layman.

—Lectures on the Elements of Chemistry, delivered in the University of Edinburgh; by the late Joseph Black, M.D. Professor of Chemistry in that University. Published from his manuscripts by John Robison, LL.D. Professor of Natural Philosophy in the University of Edinburgh. First American edition from the last London edition. Philadelphia: 1806.

WILLIAM JAMES MACNEVEN

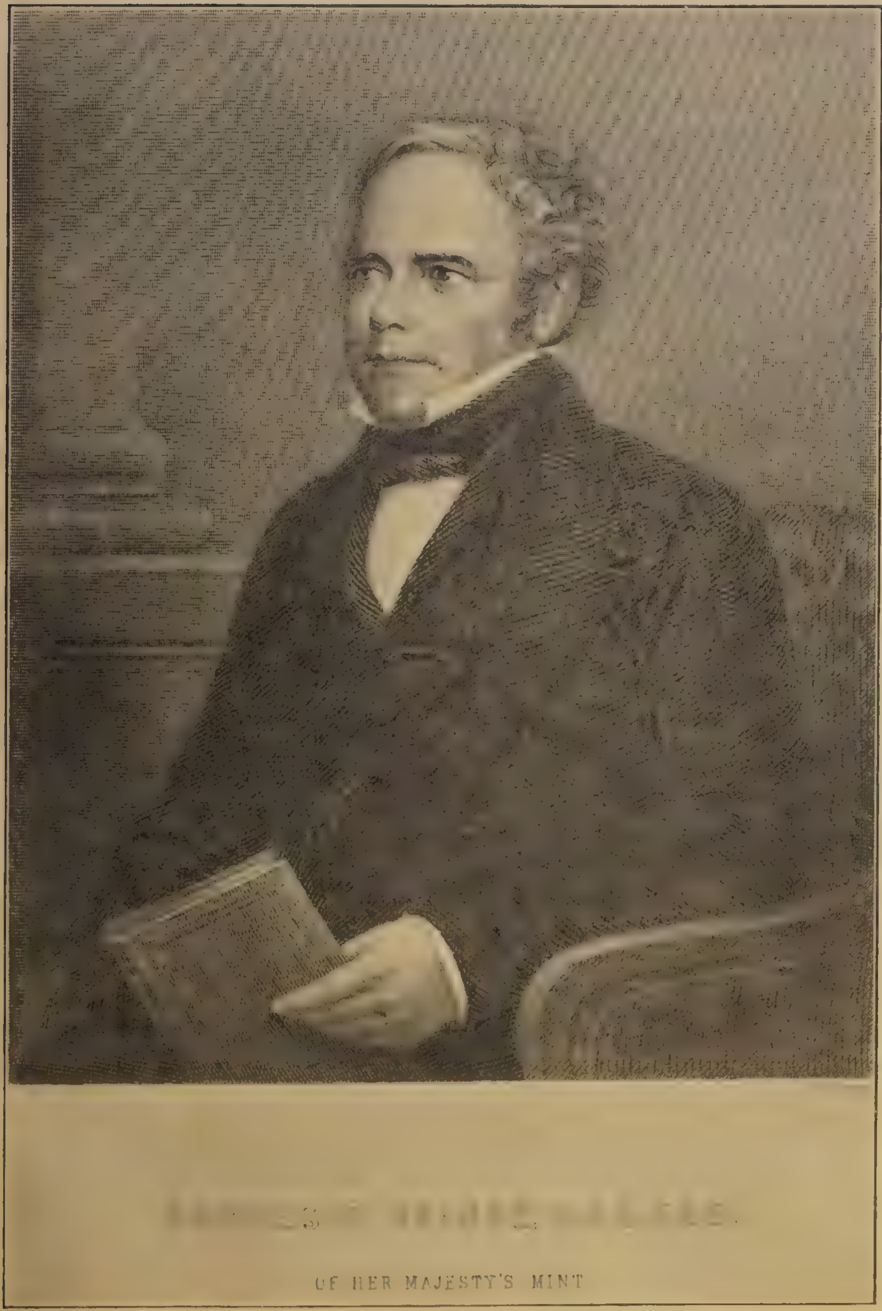
In the first quarter of the nineteenth century William James Macneven was active as a teacher of chemistry in New York; in fact, he was professor of the science in the College of Physicians and Surgeons of the University of the State of New York. He was a man of mark and great influence in his adopted American home, all of which is amply set forth in the beautiful memorial shaft standing in the yard of old St. Paul's Chapel, New York City. Having prepared various guide books for laboratory use by his students, he projected

> a class book that should comprehend in regular order, the text of what is delivered in lectures, and what is expected from the candidate at examination, a thing altogether desirable for professor and student—but I opportunely received Mr. Brande's Manual . . . Having perused this well arranged outline of a Course of Chemistry, I deemed my projected undertaking unnecessary.

So he proceeded to send forth his edition of Brande (the first American from the second English edition) in 1821. The Brande book appeared originally in 1819. Parts of the English work were omitted, and it was copiously annotated by Macneven, making it very acceptable for student use.

In 1828 John White Webster, Erving Professor of Chemistry and Mineralogy in Harvard University published a "Manual of Chemistry" based on Brande's work. Silliman, the Elder, was most favorably impressed with this volume, since he recommended it when the Chemistry of Henry could no longer be obtained. Webster bore the reputation of being a good teacher and was particularly active in the extension of laboratory methods. He was proficient in mineral analysis. In the Boston Journal of Philosophy and the Arts (1824) 1, p. 390, he submitted his results of the analysis of a green feldspar, decomposed by fusion with boric acid, as originally suggested by Dr. Humphry Davy in the Philosophical Transactions for 1805; a method which, how ever, Jannasch later (Z. f. anorg. Ch. 12, 208) set forth as original with himself, but which he might have found fully described in Buff's *Handbuch der analytische Chemie, Vol.* 1, *p*. 336 (1821). Webster also published Liebig's Animal Chemistry or Organic Chemistry "in compliance with the wishes both of the author and of the translator (Gregory)." It was the only authorized American edition. He was, too, the editor (1827) of Fyfe's *Elements of Chemistry, for the Use of Schools and Academies.*

The Macneven and Webster Americanized editions of the Brande text enjoyed a fairly large class of admirers. The original was a contribution on the order of that of Thomson altho apparently not so popular as the latter even in its native land. In its first edition it contained a very concise but excellent historical sketch. Frequent reference was made to it by other contemporary text-book writers. This feature was not preserved by Macneven or by Webster. Some points in the original volume deserve consideration. To begin Brande dedicates his book to Charles Hatchett, F.R.S., the same who discovered Columbium.



William Thomas Brande.

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He was Brande's "first instructor in chemistry," and also his father-in-law. The original book had not a little to say on geology, but this also was discarded by the American editors. Brande remarks in his preface:

> Much of this work has been written in the Laboratory, where the results of experiments have been immediately transferred to its pages; and where I have uniformly received the active and able assistance of Mr. M. Faraday, whose accuracy and skill as an operator have proved of essential service in all my proceedings.

He further adds:

> As students, especially, are apt to throw off the burthen and responsibility of thinking for themselves, by adopting the notions of others, without either weighing their merit or appreciating their correctness, and often only because they are new, I shall beg leave to call their attention to one of the relevant passages of Lord Bacon, who wrote—
>
> He who would become duly prepared and fitted to the business of interpretation, must neither be a follower of novelty, custom, nor antiquity; nor indulge himself in a liberty of contradicting; nor servilely follow authority. He must neither be hasty in affirming, nor loose and sceptical in doubting; but raise up particulars to the place assigned them by their degree of evidence and proof. His hope must encourage him to labour, and not to rest; he must not judge of things by their uncommon nature, their difficulty, or their high character, but by their just weight and use. He must, in his own particular, carry on his view with concealment, and yet have a due regard for posterity. He must prudently observe the first entrance of errors into truths, and of truths into errors, without dispising or admiring anything. He must understand his own talents and abilities, or the advantage of his own nature. He must comply with the nature of others. He must, as with one eye, survey the natures of things, and have the other turned toward the human uses. He must distinctly understand the mixed nature of words; which is extremely capable both of prejudicing and assisting. He must lay it down to himself, that the art of discovering will grow up and improve, along with discoveries themselves. He must not be vain either in delivering or concealing the knowledge he has acquired; but ingenuous and prudent, and communicate his inventions without pride or ill-nature; and this in a strong and lively manner, well defended against the injuries of time, and fit for the propagation of knowledge, without occasioning errors; and, which is the principal thing of all, it must be such as may select and choose for itself a prepared and suitable reader.

The habit of early text-book writers to moralize either in a prefatory way, or in the body of the text, would now be looked upon with disdain and contempt.

—Manual of Chemistry by William Thomas Brande. First American from the second London Edition, to which are added Notes and Emendations by William James Macneven; M.D., Professor of Chemistry in the College of Physicians and Surgeons of the University of the State of New York. 1821.

FRANKLIN BACHE

Another volume entitled to notice is "*A System of Chemistry* (1819) by Franklin Bache." This author at one time assisted Robert Hare in his chemical pursuits and from him probably imbibed a keen interest in the science, particularly as a teacher, so although this "System" was designed primarily for medical students, its author discussed its contents "without reference to its use of any particular class of readers."

Bache entertained very definite thoughts on the science and did not hesitate to introduce them into his text. Thus he wrote—

> In treating of matter, contrary to the common usage, I have commenced with its ponderable forms and afterwards taken up the consideration of imponderable matter. In pursuing this course, I have been influenced by the general principle, that in works intended to convey elementary information, it is proper to proceed, as far as practicable, from the easy to the more difficult parts of the subject. I have considered the attractions with which chemistry is concerned, after matter, since all that can be said upon this subject must be the result of the generalization of chemical facts. To have pursued a contrary order, would have been to disregard the fundamental principle of proceeding from the known to the unknown . . .

And he further wrote:

> With regard to the names adopted which are not in current use in this country, I feel very desirous that some of them should get into general use. I here allude particularly to the chemical names, invented by Gay-Lussac, of hydrochloric acid and hydrocyanic acid, instead of the usual ones of muriatic acid and prussic acid. About the fate of the names which I have myself proposed, I feel little solicitous.

Franklin Bache.
IN THE JEFFERSON MEDICAL COLLEGE OF PHILADELPHIA

Franklin Bache.

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There is evidence that Bache based his work to some extent on the system of Thomson, although Accum's and Davy's writings were consulted. Other current literature was carefully considered. An interesting application of nitric acid may be cited:

> Nitric acid, in a state of vapor, has been employed to destroy the contagion, or noxious effluvia, with which jails, hospitals, ships and over-crowded places, are liable to become infected. The manner in which it is employed is to put half an ounce of nitrate of potash (nitre) in a saucer, placed in an earthen vessel, filled with heated sand. To the nitrate of potash, two drams of sulphuric acid are to be added; which decomposes the nitrate, the nitric acid flying off in a state of vapour. The nitric fumes, from the decomposition of half an ounce of nitrate of potash, are calculated to be sufficient to fill a cube of ten feet. The application of nitric acid vapour, to the purpose of purifying infected apartments, was first made by Dr. Carmichael Smyth; who received for his discovery, from the British government, a reward of five thousands pounds.

The book is most praise-worthy. Its merits are numerous. It probably contributed in laying the way for Bache's advancement to the Professorship of Chemistry in Jefferson Medical College.

—System of Chemistry for the Use of Students of Medicine, by Franklin Bache, M.D. Philadelphia. 1819.

SAMUEL L. DANA

The Muck Manual appeared early in the eighteen thirties. It was intended for farmers. Its author was Samuel Luther Dana, who said in his preface:

> The author is not an agriculturist, he does not assume the name even of agricultural chemist. Practical chemistry is his profession and has been for some thirty years. During the greatest portion of this time he has been attached as chemist to the Print works of the Merrimack Manufacturing Company, in Lowell, while pursuing there, during the years 1835, 1836 and 1837 researches on the action of cow-dung in calico-dying, he pushed his inquiries, as a recreation during his few leisure hours into the nature and action of manures and of soil.

A neat introduction to probably, the first volume written in America on a very interesting division of chemical science, viz. agricultural chemistry.

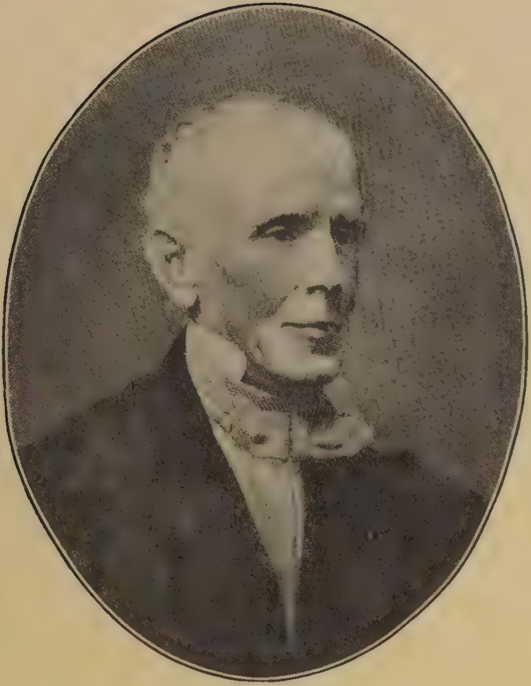
The work was favorably received at home and abroad, where a considerable portion was printed. It passed through several editions.

Probably the reader will smile enquiringly on reading the title "Muck Manual" although he may confidently accept it as a volume on agricultural chemistry. But, the author remarked:

> One word respecting the title of my book. It is my own. I have neither begged, borrowed, or stolen it. That last has been done by an English Author, who seems to be ashamed not of the act, but of the name he has filched from me, and so eases his conscience by apologizing for his "homely title." I shall not discredit my child by being ashamed of his name. It was good at the christening, and I trust will be thought respectable in manhood.

If students of chemistry in this land will only read the earliest volumes or chapters in chemistry prepared by the "fathers," they will discover much to cause them to speak with pride of our earliest workers in the science, enthusiastically cultivated in days long gone. Maybe students of agricultural chemistry do read this book; if not, they miss much. It is, of course, antiquated, but even now reads remarkably well. It was a pioneer work. Its author was alert to the application of chemical principles, and carried into farming practice the same scientific methods that he had found so important to success in technical inquiries, and added an overflowing love for the pursuit in all of its varied bearings. Dana's scientific labors were constant for the benefit of others, but his modesty and sphere of action precluded deserved public acknowledgment and praise.

With the writer there exists a pressing desire to bring additional old volumes into this collection of literature which influenced and shaped chemical thought at a time when many things, —yes, almost everything—was in its beginning stage in this country.



Samuel L. Dana.

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But bearing in mind the original purpose to call attention only to chemical literature as it flourished in the days of the American Fathers of Chemistry, it is believed that enough has been said to arouse the curiosity of students of historical chemistry. Their zeal for the subject will lead them to additional material which will reward their efforts of search. In this way, they may gather about them, as has the writer, a library of such literature. It is superfluous to reiterate what has so often been said, viz. that such a course will instil a deeper regard for the historical and cultural side of the science. The criticism that chemistry is absolutely commercialized is frequently heard and, further, that it is the commercial value of the science alone which claims the thought of chemists. Such views are widely prevalent. But other ideas exist, and chemistry teachers especially know that to them the discarded "old chemistries" bring many other messages—messages in history, in philosophy, in economics, in social relations, in art, in international relations, in literature, and in a wide and extensive culture.

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